POWER

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Narrow-Gage Thinking

"I DON'T ride on the railroad much, anyway," said one of a group that was discussing the maintenance of wartime rates for railway service.

It was a striking example of the breadth of view of the sovereign citizen whose vote helps in deciding the issues of the nation.

Because he seldom rode on a railroad, it made little difference to him whether the railways were adequate or inadequate, efficient or inefficient, or how reasonable or unreasonable their charges might be.

It was an entirely new thought to him that railroad transportation is an item in the cost of practically everything that he buys.

That every time he sits down to a meal or buys a suit of clothes or a ton of coal, he pays tribute to the railroad.

That the railroad depends upon him and such as he for its support, whether he ever rides upon it or not.

His narrow-mindedness was equaled by that of the intelligent citizen who thought that the coal question had no interest for him because he lived in an apartment house where the heat was furnished.

Aside from the fact that the cost of heating is an important item in the determination of the rent which he has to pay, is the fact, which apparently never occurred to him, that coal is an item in the cost of practically everything that he buys. It drives the locomotives and steamboats that transport the materials, it drives the factories that fabricate them, it heats the buildings in which they are stored and merchandized.

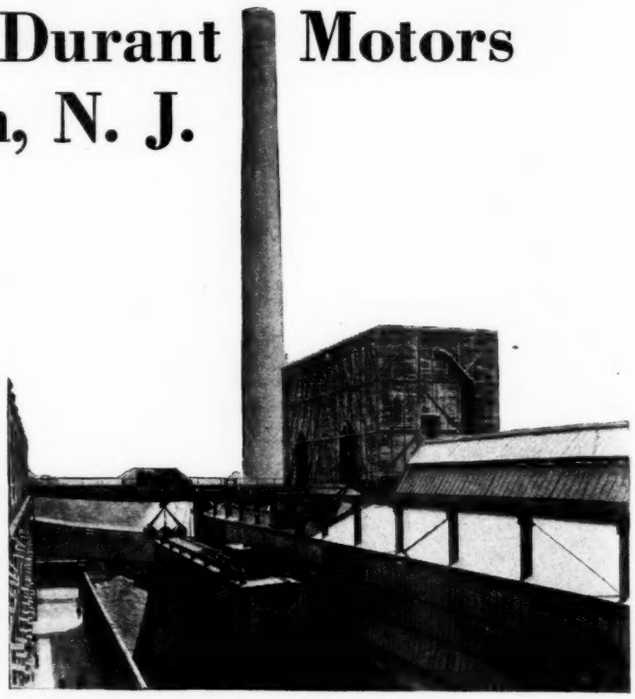
Indirectly he pays for more tons of coal a year than the householder puts into his cellar.

The sovereign citizen should look sidewise once in a while.

F. R. Low

Power Plant of the Durant Motors Elizabeth, N. J.

POWER plant of 8,750 kva. capacity designed especially for industrial service. Boiler plant contains six 6,020 sq.ft. water tube boilers fired with traveling-grate stokers. Turbine-driven forced-draft fans installed in front of boilers. Steam for process and heating supplied by exhaust from steam-driven auxiliaries and extraction from main units. Average power factor maintained on plant, 95 to 98 per cent.



SITUATED in the heart of the industrial district of the State of New Jersey is the new plant of the Durant Motors at Elizabeth. Construction of the plant was begun in 1919 and finished during the latter part of 1921. It was not, however, formally put into operation until about twelve months later.

The plant is possibly one of the largest yet built in a single unit for the manufacture of automobiles, the floor space being approximately 2,100,000 sq.ft. It is excellently situated for transportation facilities, being adjacent to the main line of the Pennsylvania Railroad as well as having switching facilities to three other important railroads.

Steam for heating and process and current for power and lighting are supplied by a steam-turbine generating station adjoining the plant.

The power-house building is of structural steel frame with brick walls and reinforced-concrete floor. The lower portion of the interior wall of the turbine room is built with glazed brick, and liberal daylight illumination has been provided. The building is approximately 80 ft. wide and 140 ft. long, divided into two sections, a boiler room 45 ft. wide and a turbine room 35 ft. wide. The floor of the boiler room is at ground level, as also is the basement floor of the turbine room, the main floor of the turbine room being 12 ft. higher. The switchboard is on the turbine-room floor with the busbars and circuit breakers in a bay directly behind.

Moderate-Sized Boilers Installed

It was estimated that the average steam demand would be around 125,000 lb. an hour during the winter months. Of this 60,000 lb. would be used in heating and process and the balance in generating the necessary power. To supply this steam, moderate-sized water-tube boilers of the bent-tube type were installed.

In the selection of auxiliaries reliability was considered the most important factor, for with the exception of one service pump and one exciter, all are steam-driven.

Since a considerable portion of exhaust steam required for heating and process would be furnished by the auxiliaries, generating units of the bleeder type were selected to operate condensing at high vacuum and supplement the exhaust-steam supply as necessary by bleeding from the second stage.

In addition to the current required for operating the numerous motors and for lighting, approximately 2,500 kw. per hour is consumed in the heating of process ovens. The average power factor maintained on the plant averages from 95 to 98 per cent.

The boiler room contains six 6,020-sq.ft. water-tube boilers of the cross-drum type with a connection-type superheater in the second pass. They are designed for a working pressure of 200 lb., but operate normally at 190 lb. gage and approximately 125 deg. superheat. The boilers are set two to a battery, with liberal operating aisle space in the front and rear.

Each boiler is fired by a chain-grate stoker having 140 sq.ft. of active grate area, which bears a ratio to the steam-making surface of 1 to 43. The arrangement of the baffling and furnace arch is shown in the sectional view of the boiler in Fig. 4. An insulated compressed asbestos breeching carried along at the rear of the boilers connects them with a reinforced-concrete stack 7 ft. in diameter at the top and 227 ft. high, located outside and independent of the building.

Stokers Driven by Steam Engine Through Double-Reduction Worm-Gear

Each stoker is driven by a two-cylinder single-acting steam engine installed at the rear of the boiler and belted to a double-reduction worm-wheel drive (see Fig. 6), the main driving shaft being carried along the side of the boiler setting to the rear of the stoker. The speed of the stoker is regulated by changing the speed of the engine to give the desired rating.

Air for combustion is supplied by two turbo-vane fans each with a capacity of 90,000 cu.ft. per min. against 4 in. water pressure and driven by a 125-hp. steam turbine. They are in a bay in front of the boilers and draw their air supply from the boiler room. The fans discharge into a common concrete air duct below the floor, running the full length of the boiler room with a branch leading off to each boiler. The installation of these fans in front of the boilers permits of greater accessibility, and their close proximity to the operator insures attention and less liability to shutdown.

The windbox under the stoker grates is divided into three compartments, the pressure in each being reg-

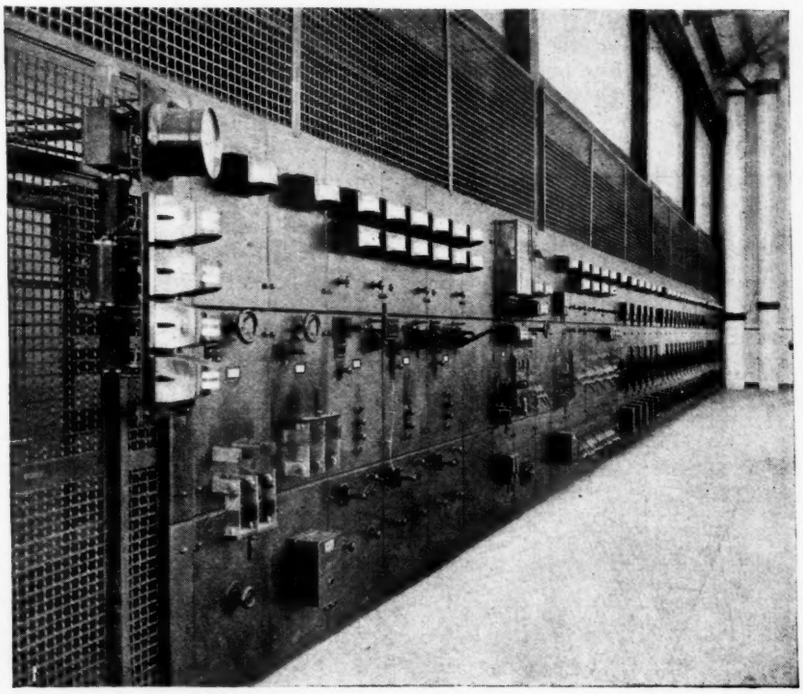


FIG. 1—SWITCHBOARD LOCATED ON TURBINE ROOM FLOOR, CONTAINS OPERATING AND DISTRIBUTION PANELS

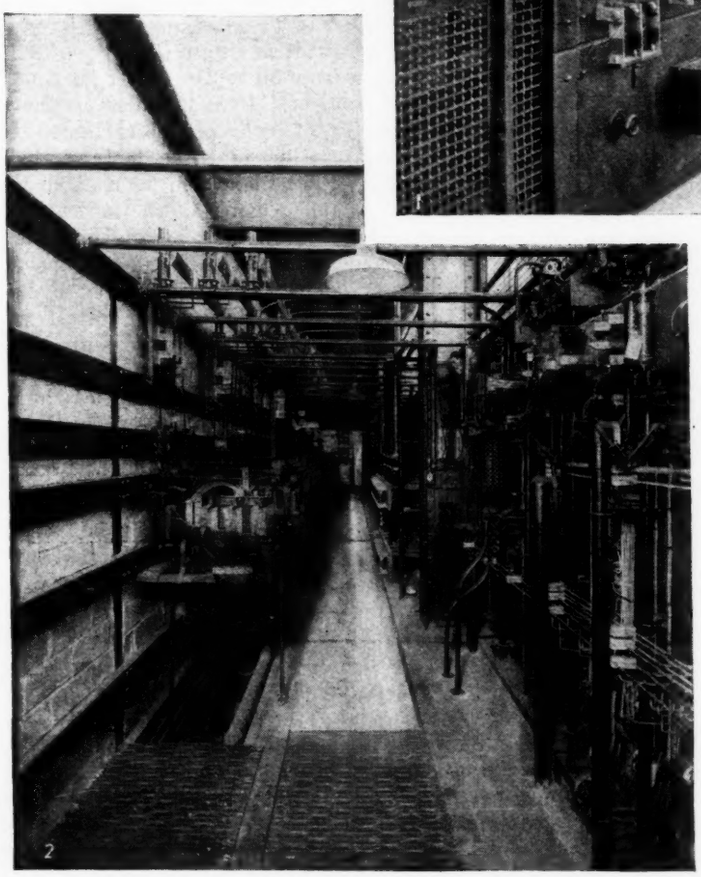


FIG. 2—BUSBARS AND SWITCH GEAR AT REAR OF OPERATING BOARD CIRCUIT BREAKERS ARE SOLENOID OPERATED

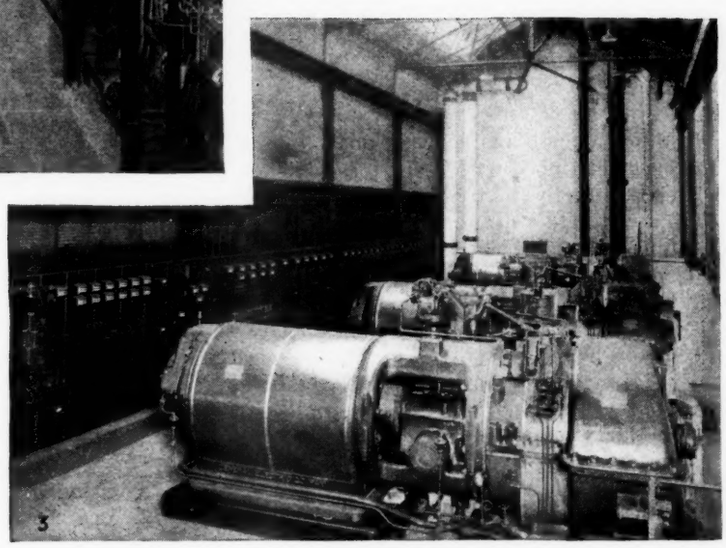


FIG. 3 — GENERATING EQUIPMENT CONSISTS OF TWO 2,000-KW. AND ONE 3,000-KW. BLEEDER TYPE TURBO-GENERATOR UNITS

ulated by a slide-gate in branches coming off the main air duct. A multi-tube draft gage indicates the air pressure in each compartment.

Ashes discharged at the rear end of the stokers fall into reinforced-concrete brick-lined hoppers from which they are removed by a steam-jet conveyor and discharged to an elevated concrete bunker outside the building and above the coal track. At intervals the ashes are delivered through a chute by gravity to a railway car and hauled away.

Coal used at the plant is small-sized anthracite commonly termed rice and barley. It is received by rail in bottom dump cars and discharged to a track hopper adjacent to the boiler house. The coal is removed from

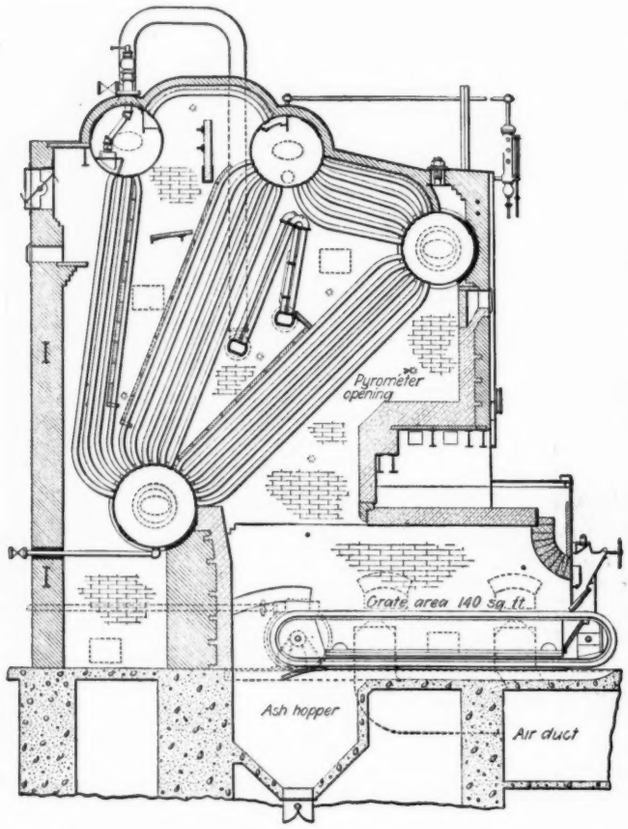


FIG. 4—SECTIONAL ELEVATION THROUGH BOILER SETTING SHOWING ARRANGEMENT OF FURNACE ARCHES AND BOILER BAFFLING

the unloading hopper by a three-phase motor-driven traveling crane equipped with a one-ton clamshell bucket and delivered directly to the bunkers above the firing aisle or to a concrete storage bin of 5,000 tons capacity (see headpiece). The coal is recovered from storage in the same way. To facilitate the handling of the cars in the yard when unloading, a motor-driven car puller is provided. Distribution of the fuel to the individual stoker hoppers is by means of an electrically operated weighing larry controlled from the boiler-room floor. A one-ton weighing hopper is suspended from the frame of the larry, and the weighing is done by a beam scale located at a convenient height above the floor. A number of openings in the bottom of the bunker are provided with hand gear operated gates and permit coal to be taken from any part of the bunker.

Each boiler is equipped with a high- and low-water alarm column, mechanical soot blowers, feed-water regulators and a steam-flow indicating dial on the boiler front. As a means of keeping a check on the furnace performance, a combined draft gage and CO_2 indicating and recording instrument is installed for each boiler.

The main steam header is carried along at the rear of the boilers and connected to the superheater outlet at the side of each boiler through a 6-in. diameter long-radius bend equipped with an automatic non-return and stop valve. The leads to the main turbines, which are in the form of long-radius U-bends, are taken directly off the header and carried through the engine-room wall and up through the floor directly at the turbine connection.

Heater Installed Between Boiler Batteries

The feed water and exhaust header parallel the main steam line. All pipes are supported from the steel structure of the plant. The main boiler blowoff line is equipped with a master valve and connects to the mud drum of each boiler through 2½-in leads and a tandem blow off valve.

An open metering heater having a capacity of 210,000 lb. of water per hour from 50 to 210 deg. F. is a part of the boiler-room equipment. It is installed in the aisle between two batteries of boilers and arranged for a short and direct connection to three 3-stage turbine-driven feed pumps on the boiler-room floor. The heater is furnished with a V-notch meter of the indicating and recording type. The location and arrangement of the pumps and heater, permit of cleanliness of operation, ease of supervision and give the necessary hydraulic head over the pumps for handling the hottest water. All pumps are automatically controlled through differential pressure regulators. The main supply of boiler-feed water is obtained from the condensate of the main turbines, and to this is added the returns from the heating system, which are handled by three 19x12x20-in. vacuum pumps in the boiler-room basement. These pumps discharge directly to the feed-water heater.

The electrical generating equipment consists of three high-pressure bleeder-type condensing steam-turbine units delivering three-phase 60-cycle current at 480 volts. Two of the units are rated at 2,000 kw. at 80 per cent power factor and one at 3,000 kw. at 80 per cent power factor. The 3,000-kw. unit is of the usual extraction type, while the two 2,000-kw. units are of the mixed-pressure type. The latter units are arranged for bleeding steam between the second and third stages, and also for receiving steam at this point and passing it through the low-pressure stage to the condenser. The amount of steam bled from the turbine is regulated by a gear under control of a diaphragm valve that can be adjusted to maintain any desired pressure in the exhaust header.

Air Removed from Condenser by Two-Stage Ejectors

Each turbine is connected to a surface condenser capable of condensing 52,000 lb. of steam per hour at 28.5 in. vacuum with cooling water at 70 deg. F. They are supported on steel columns from the basement floor. The condenser is of two-part construction, consisting of the main condenser containing tubes and an external cooler containing air-cooling and devaporizing surface consisting of cast-iron grids.

Circulating water is supplied to each unit by an independent turbo-driven centrifugal pump 4,300-g.p.m. placed alongside of the main-unit foundation. The condensate pump is also of the centrifugal type and is direct connected to the circulating-pump shaft.

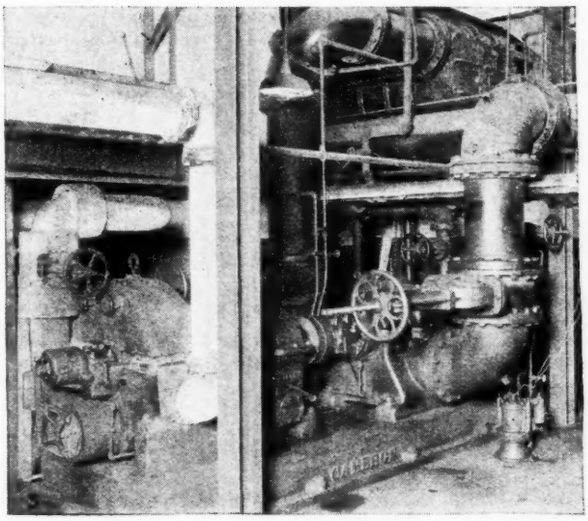


FIG. 5—ABOVE, LEFT CENTRIFUGAL CIRCULATING AND CONDENSATE PUMPS TURBO DRIVEN THROUGH REDUCTION GEAR

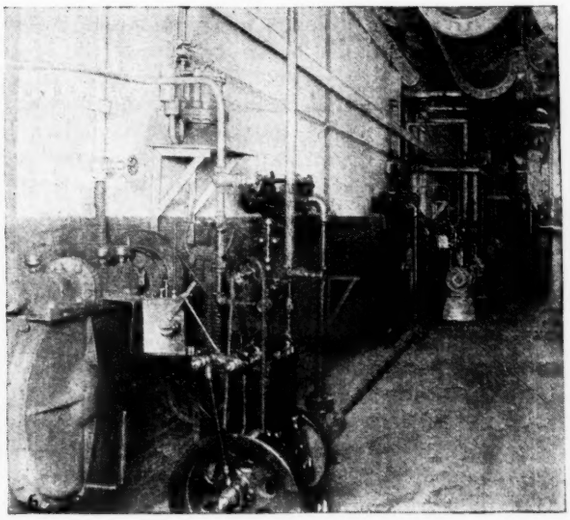


FIG. 6—ABOVE, RIGHT. TWO CYLINDER SINGLE ACTING STEAM ENGINES BELTED TO DOUBLE REDUCTION WORM WHEEL DRIVE ON STOKER

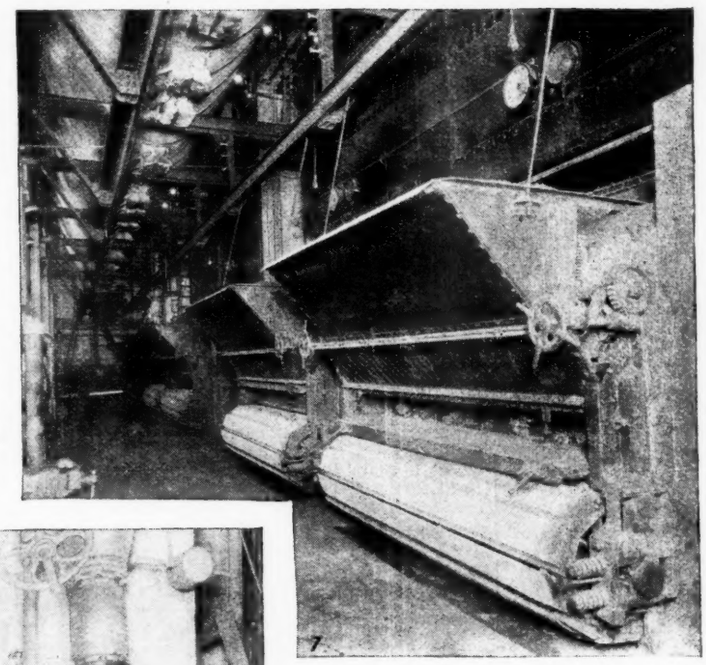


FIG. 7—LEFT. BOILER ROOM FIRING AISLE, WITH OVERHEAD COAL BUNKER, BOILERS FIRED BY TRAVELING GRATE STOKER

FIG. 8—BELOW, LEFT. OPEN METERING HEATER AND 3-STAGE TURBO-DRIVEN FEED PUMPS LOCATED BETWEEN BOILER BATTERIES

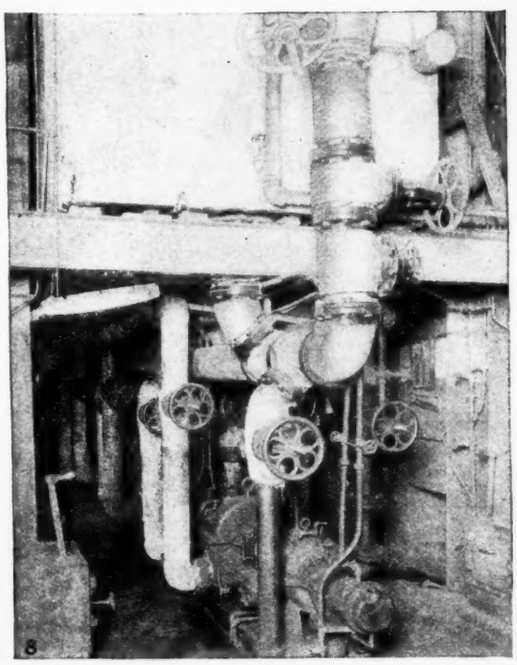
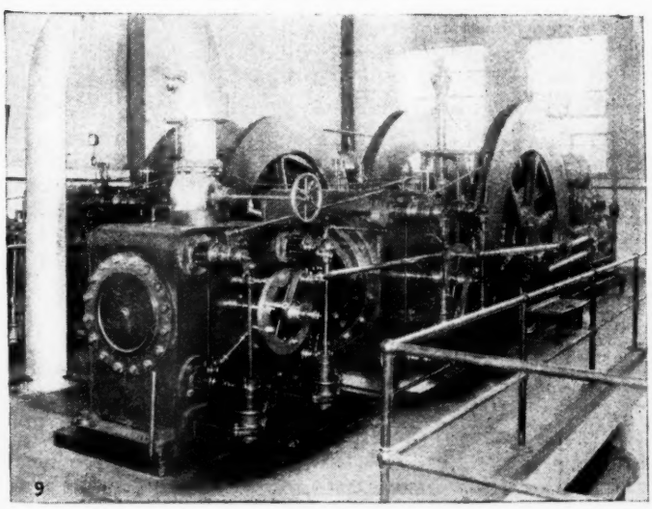


FIG. 9—BELOW, RIGHT, COMPOUND STEAM ENGINE-DRIVEN AIR COMPRESSORS INSTALLED ON TURBINE ROOM FLOOR



For removing the air from the condenser, two-stage ejectors with intercoolers are provided. The secondary jets discharge to an expansion tank into which the condensate is also discharged before passing to the heater. The primary jets are mounted on the dome of the external air cooler and discharge into an inter-condenser integral with the cooler. In the inter-condenser the steam discharged by the primary jets is condensed by a jet of condensate that is finally trapped back to the condensate pump suction.

Cooling Tower Employed

In the headpiece is shown the circulating-water cooling tower mounted on the roof of the plant. The tower is of the forced-draft type and of all-wood construction, measuring 30 ft. wide, 80 ft. long and 35 ft. high. It is fitted with twelve 9-ft. fans and has a capacity to cool 9,800 gal. of water a minute from 96.5 deg. to 80 deg. with atmospheric condition at 70 deg. air temperature and 70 per cent relative humidity. The fans are arranged in pairs right and left hand and are direct connected to a 30-hp. motor. The operation of the motor is controlled from the main switchboard in the turbine room.

Excitation for the main generator units is furnished by one 75-kw. 125-volt motor-driven exciter and one 50-kw. 125-volt machine driven by a 115-hp. single-stage non-condensing turbine. These units are on the turbine-room floor between the main units. The motor-driven unit operates continuously; the steam-driven one serves as a spare and is used only for emergency service.

A view of the switchboard is shown in Fig. 1 and the busbar and switch-gear installation in Fig. 2. On the swinging panel at the left-hand end of the board are grouped the synchronoscope, d.c. voltmeter, a.c. voltmeter and the power-factor meter.

The board is equipped with a Tirrel regulator for voltage control and with inverse time and overload relays on all circuit breakers. The main generator and feeder breaker are solenoid operated, current being supplied from a storage battery or charging generator. The battery charging panel is incorporated in the main switchboard. Another panel carries six push-button starting compensators for the motor-driven fans in the cooling tower on the roof of the plant. Three 200-kva. 480 to 110-220 volt transformers are located in the basement for supplying the lighting and other services throughout the works. Two graphic wattmeters record the total station and oven-circuit loads respectively. Additional equipment in the engine room includes two compound Corliss engine driven air compressors of 2,450 cu.ft. per min. capacity, supplying compressed air to the works at 105 lb. pressure. The compressors are fitted with Corliss-type intake valves and feather-edge

PRINCIPAL MECHANICAL EQUIPMENT IN THE POWER PLANT OF THE DURANT MOTORS CO.

BOILERS

Manufacturer	D. Connelly Boiler Co.
Type	Cross-drum water-tube
Number installed	6
Heating surface, sq.ft.	6,020
Heating surface per sq.ft. of grate area	403
Working pressure, lb. gage	190
Superheater (Foster)	Power Specialty Co.
Superheater surface, sq.ft.	714
Superheat deg. F. normal rating	125
Coal burned	Small anthracite

STOKERS

Manufacturer	Combustion Engineering Corp.
Type	Coxe traveling grate
Grate area, sq.ft.	140
Drive	Double-reduction wormwheel, belted steam engine
Draft	Natural

FORCED DRAFT FANS

Manufacturer	Green Fuel Economizer Co.
Number installed	2
Capacity cu.ft. per min. against 4 in. water static pressure	90,000
Drive	125-hp. Terry turbine

CHIMNEY

Builder	General Concrete Constr. Co.
Type	Reinforced concrete
Diameter at top, ft.	7
Height above grate, ft.	227

FEED-WATER HEATER

Manufacturer	Warren Webster & Co.
Number	1
Type	Open
Capacity, lb. per hour	210,000
Feed-water measurement,	Lea V-Notch indicating and recording meter

BOILER-FEED PUMPS

Manufacturer	Worthington Pump & Mach. Corp.
Number	3
Type	3-stage centrifugal
Size, in.	3
Speed	2,750 r.p.m.
Capacity, gal. per min.	225
Drive	50-hp. steam turbine
Manufacturer	Terry Steam Turbine Co.

AIR COMPRESSORS

Manufacturer	Sullivan Machinery Co.
Number	2
Drive	Corliss type steam engine
Pressure, lb. gage	105
Capacity, cu.ft. per min., free air	2,450

GENERATING UNITS

Manufacturer	General Electric Co.
Number	3
Type	4-stage, extraction, condensing
Capacity each	Two 2,000-kw. one 3,000-kw.
Type of generator	Alternating-current 3-phase, 60-cycle, 480 volts
Switchboard	General Electric Co.
Exciters	General Electric Co.
Number	2
Capacity,	One 75-kw. motor-driven, one 50-kw. steam turbine-driven
Condensers	Ingersoll-Rand Co.
Number	3
Type	Surface
Tube surface, sq.ft.	3,100
Performance	28.5 in. vacuum, 52,000 lb. steam 70 deg. water
Air ejectors (two-stage)	Ingersoll-Rand Co.
Number, each condenser	2-primary, 2-secondary
Circulating pumps, centrifugal	Ingersoll-Rand Co.
Capacity, gal. per min.	4,300
Drive, 125-hp. turbine through reduction gear,	Terry Steam Turbine Co.
Condensate pumps, centrifugal, 120 gal. per min.,	Ingersoll-Rand Co.
Cooling tower	C. H. Wheeler Mfg. Co.
Type	Forced draft, wood construction
Size	30 ft. wide, 80 ft. long, 35 ft. high
Capacity,	9,800 g.p.m. from 96.5 deg. to 80 deg. with 70 deg. temp., 70 per cent humidity.
Number of fans	12
Drive (two fans per motor)	30-hp. motor

MISCELLANEOUS EQUIPMENT

Two fire pumps:	
One duplex, 20 x 14 x 18 in.	Worthington Pump & Mach. Corp.
One centrifugal, 1,500 gal. per min.; driven by Terry turbine,	Goulds Mfg. Co.
Three service pumps, centrifugal, 400 gal. per min.,	Goulds Mfg. Co.
Drive, one 30-hp. motor	General Electric Co.
Two 25-hp. steam turbines	Terry Steam Turbine Co.
Vacuum pump, three Simplex	American Steam Pump Co.
Traveling crane (coal handling),	Milwaukee Elec. Crane & Mfg. Co.
Traveling coal larry	Guarantee Constr. Co.
Ash conveyor	Conveyors Corp. of America
Soot blowers, 6 element per boiler	Vulcan Soot Cleaner Co.
Non-return valves	Golden-Anderson Valve Specialty Co.
Blowoff valves	Everlasting Valve Co.
Feed-water regulators (Copes)	Northern Equipment Co.
Gate valves	Chapman Valve Mfg. Co.
Reducing valves	Fisher Governor Co.
Traps	Wright-Austin Co.
Safety valves	Crosby Steam Gage & Valve Co.
Co_2 recorders	Jos. W. Hays Corp.
Flow meters	Republic Flow Meters Co. and Gen. Elec. Co.
Water columns	Reliance Gauge Column Co.
Multi-tube draft gage	Paul B. Huyette Co., Inc.
Piping	M. W. Kellogg Co.
Graphic Wattmeters	Esterline-Angus Co.
Pipe covering	Johns-Manville
Furnace arches	H. M. Detrick Co.
Consulting engineer	P. L. Battey

discharge valves. They discharge directly to a 7x15-ft. receiver placed outside the plant.

An interesting feature is the flow-meter installation recently completed. The instrument board shown in Fig. 10 is in the turbine room. The integrator and recorder at the extreme left are utilized for checking or calibrating any one of the other instruments on the board. This is accomplished by interconnecting the meters through a series of jacking-in points shown in the lower left-hand corner of the board. This system was developed by W. B. Kollar, superintendent of power, and has increased greatly the practicability of the installation. The meter bodies are placed in any convenient position near the orifice plate in the pipe line. As a guide for the stoker operations an indicating dial graduated in hundreds of horsepower is installed on the front of each boiler.

To readers who are not familiar with the bleeder or mixed-pressure type of turbine, a description of the extraction gear referred to earlier in the article may be of interest.

Referring to Fig. 11, the construction and principle of operation will be readily understood. The diaphragm *A* fitted with a sliding gridiron valve *B*, is placed across the turbine cylinder at a point where it is desired to bleed the turbine. The valve ring *B* is connected to the steam-actuated piston *C* and is so operated as to cover or uncover successively passages in the diaphragm leading to nozzles, thereby maintaining constant pressure in extraction stage under varying loads. The piston *C* is operated through pilot valve *D*, the travel being controlled by the diaphragm valve *E*, which is connected to the extraction line. An adjustable equalizing spring *F* balances the extraction line pressure on the diaphragm. By adjusting this spring, the pressure in the extraction line may be maintained at the desired point.

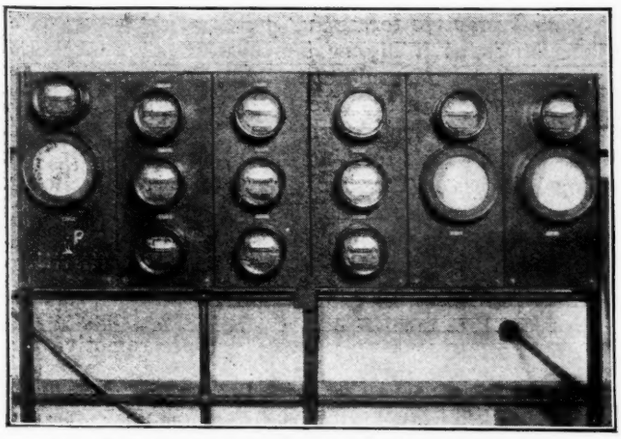


FIG. 10—FLOW METER INSTRUMENT BOARD IN TURBINE ROOM

Water for boiler-feed makeup, condenser cooling and other services around the plant is obtained from four 600-ft. air lift wells, located on the plant property. The water from the wells is discharged to a 500,000-gal. storage tank. A connection is also made with the city supply. The house service is supplied by three 400-g.p.m. centrifugal pumps in the engine-room basement. Two of the pumps are direct connected to 25-hp. turbines and the other to a 30-hp. induction motor. For fire protection a 20x14x18-in. duplex pump and a 1,500-g.p.m. turbo-driven centrifugal pump are installed on the boiler-room floor.

The steam supply to all boiler-room auxiliaries such as forced-draft fans, stoker engines and boiler-feed pumps, is taken off an auxiliary header which is tapped into the main header at each end. Both the main header and auxiliary headers are sectionalized so that steam can be carried on the auxiliaries as long as one battery of boilers is in operation. All high-pressure piping is

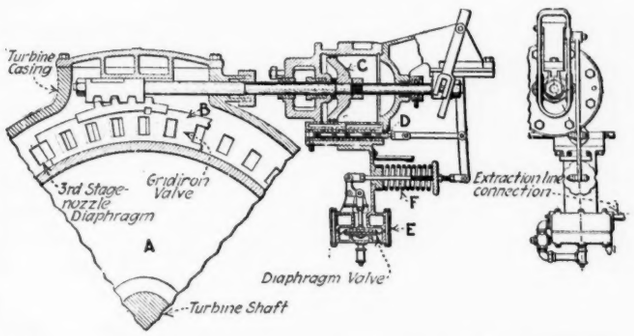


FIG. 11—EXTRACTION GEAR ON TURBINE, PRESSURE CONTROLLED BY OPENING OR CLOSING SUCCESSIVELY PASSAGES IN DIAPHRAGM BETWEEN STAGES

extra-heavy with rolled-steel Vanstone joints, and all steam and hot-water pipes are well insulated to prevent heat loss. Eighty-five per cent magnesia has been used throughout and is covered with 8-oz. canvas. The main steam header in the boiler room is furnished with a gallery so that all valves are accessible.

Live Steam Supplements Low-Pressure Process Steam

The exhaust from some of the boiler-room auxiliaries is led directly to the heater and the balance to the main exhaust header from which the steam is distributed to different parts of the works. The pressure in this header is normally carried at 2 lb. gage. To supplement the supply of exhaust and bleeder steam, should an emergency arise, a live steam header is also installed, with a reducing valve connected between it and low-pressure heating header.

The piping is so arranged that practically all overhead lines have at least six feet clearance to the floor and there are practically no pipes on the floor or at such an elevation as to be in the way of the operator.

The plant is operated under the direction of W. B. Kollar, superintendent of power, and F. Dwight Campbell, chief engineer.

Power wishes to acknowledge the co-operation and assistance rendered by the chief engineer and his staff in the preparation of this article.

CORRECTION—In the Sept. 4 issue, page 356, the economizer performance given in the Mac-Sim-Bar boiler-house description is in error, as the heat absorbed by the water is slightly in excess of that given out by the gases. The discrepancy arose by taking operating figures for the temperatures and approximating the weights of gas and water. The official tests have not been made, but the guarantee, taking 55,000 lb. of gas per hour, 22,500 lb. of water and a gas temperature of 550 deg. F. entering the economizer, called for a rise in the water temperature of 100 deg. F.

The Selection and Care of Pyrometers

By J. W. CONZELMAN

THERE are a great many methods of measuring temperatures. These include, among others, the mercury thermometer, the gas-filled thermometer and the thermometer based on the expansion of a metal. All are dependent upon the expansion of a gas, a liquid or a solid and were developed at an early date.

The present article is concerned with the electric pyrometer. There are several types of this instrument, the most important being known as the thermocouple type. This instrument, is based on the principle that when the junction of two dissimilar metals is heated, a difference in electric potential develops between the two metals, this difference depending on the temperature.

The second important type of electric pyrometer is known as the "resistance pyrometer." This instrument has a coil of wire in the place of the thermocouple, this coil forming one of the legs of a Wheatstone-bridge circuit. As the temperature rises, the resistance of the coil also rises. By measuring this resistance at any time the temperature may be determined if the temperature-resistance relation is known.

The resistance type of instrument is capable in the hands of a trained operator of a precision of two degrees F. from the lowest temperature up to about 1,700 deg. F. This precision is greater than can be obtained with any other type of instrument. In the ordinary type of instrument for industrial use such precision cannot be expected nor could it be used to advantage if it were obtained.

The fact that the rate at which a black body radiates heat energy is a function of the temperature, is the basis of the third system of electric pyrometry. The instrument used is called a radiation pyrometer and consists of a collective lens or mirror which concentrates the radiant heat from a body on a small, highly sensitive thermocouple, which is, in turn, connected to a suitable galvanometer or millivolt meter. The thermocouple and lens are mounted in a tube and the operator merely points the tube at the object whose temperature he wishes to measure. This instrument is very practical and can be used to advantage to secure temperatures of furnace walls and other objects where the hot surface is of considerable extent.

The fourth and last type of electric pyrometer so far developed is known as the "optical pyrometer." The brightness of a luminous source is measured by the rate of emission of luminous radiation per unit area and depends on the temperature. In the optical pyrometer the operator compares the brightness of the given hot body with the brightness of the filament of a standard lamp. The lamp is heated till its filament color disappears in the color of the object, and then the current flowing through the lamp bears a definite relation to the temperature of the lamp and hot body. The optical pyrometer is particularly adapted to measurements of temperatures of small bodies at high temperatures. Since the comparison of colors is dependent upon the operator's eyes, the personal element enters to a certain extent in measurements with this type of instrument. However this handy little pyrometer can be used in many places where no other would be suitable.

It is evident from the description of the optical and radiation pyrometers that their range is limited to temperatures above the point where objects begin to show color. In fact, the lower practical limit for these instruments is about 1,000 deg. F. These two are generally made in the portable indicating types only.

Where a permanent installation is desired, and where a record is also of advantage, the resistance or thermocouple type is almost without exception the choice. Of these two the thermocouple instrument is more commonly used for practical work. If we limit our future discussion to a consideration of this instrument, we find that there are a number of things that have to do with its successful operation.

AFTER explaining the fundamental principles underlying the operation of the four main types of electrical pyrometer (thermocouple, resistance, radiation and optical), this article gives many practical pointers on the selection and care of thermocouple instruments. These include detailed instructions for making, calibrating and installing the thermocouples.

In the first place the complete thermocouple circuit must have at least one other junction between the two dissimilar metals to complete the electric circuit. The electromotive forces of these two junctions oppose each other. If the entire length of the circuit is of the same temperature, the two electromotive forces are equal and opposite. If one junction is at a higher temperature than the other, there will be a resultant potential that will cause a current to flow in the circuit.

The value of the electromotive force acting will depend on the metals forming the thermocouple and on the temperatures of the two junctions. In practice we call the "hot junction" the thermocouple junction and the other is known as the "cold junction," or "cold end." If we know the temperature-voltage relation of the thermocouple materials and know the temperature of the cold end, then the temperature of the hot end may be calculated from a measurement of the electromotive force developed by the thermocouple.

Various manufacturers of pyrometer equipment have devised means either to keep the cold-end junction at constant temperature by burying it in the ground to a depth of some twenty feet or more, or to heat the cold end to 100 deg. or 120 deg. or some other predetermined temperature above any possible room temperature and hold it there by suitable thermostatic control. Others have put internal compensating devices in the instrument box itself that take care of the cold-end adjustment automatically. The latter method is probably the better and is the easier to install and keep working properly.

The electromotive forces developed by the thermocouple, which bear a definite relation to the temperature of the couple, must now be measured accurately in order to complete the pyrometer equipment and make it a successful and accurate instrument.

One way is to measure this small potential by the de-

flection of a sensitive galvanometer or millivoltmeter. In the most sensitive type the moving element is suspended by a thin metallic thread above and below. A more common method is to suspend the element between two jeweled bearings. One make pivots the element from a single jeweled bearing. A strong permanent magnet furnishes a constant field to interact with the minute field produced by the suspended element and thus produce a deflection of the galvanometer.

In this millivoltmeter the permanent magnet must be of high quality, as the constancy of accuracy of the instrument depends on the permanence of the magnet.

Thermocouple Instrument with Wheatstone Bridge

One of the well-known scientific-instrument manufacturers in this country has developed a thermocouple pyrometer that is operated on a balanced-circuit system similar to a Wheatstone bridge. No current is taken from the thermocouple, and its thermo-electric potential is balanced against a standard cell. This potentiometer type of instrument depends for its constancy of accuracy on the standard cell used to produce the balancing potential. In laboratory work the potentiometer is the recognized way to measure electromotive forces, and this method is almost universally used to calibrate voltmeters, ammeters and other instruments.

This type of instrument has several advantages: The readings are not affected by the resistance of the thermocouples, lead wires, switches or any contacts. The length or cross-section of these wires does not affect the readings. Temperature changes in the leads or instrument do not affect the reading. The instrument is constant in its accuracy. Two elements only affect its constancy; one is the standard cell already mentioned and the other is the manganin wire used in the fixed resistances. Each has been proved to remain constant to a remarkable degree.

Direct-Reading Thermocouple Instruments

From the foregoing discussion it will be seen that the thermocouple voltage may either be read directly by the deflection of a galvanometer needle or its voltage may be balanced against a known voltage and thus determined. The former method is the more common way to measure the thermocouple voltage and offers the advantage of simplicity in design.

By making the resistance of the instrument reasonably high, say 500 to 1,000 ohms, it is possible to use varying lengths of leads without shunting and without seriously affecting the accuracy of the instrument.

Since the galvanometer is the measuring device in this type of instrument, it determines the accuracy and length of life of the whole equipment. The manufacturers of pyrometers have developed several variations in the method of suspending the moving element with the aim of making the instrument more sensitive to the impressed thermocouple electromotive force, and yet maintain ruggedness of construction and the maximum degree of adjustment for balancing.

The three common types of mountings are the single-pivot, the double-pivot and the suspended type of galvanometer. Taking these up in the order given, the single-pivot instrument, when properly designed and constructed is an exceptionally good one. It is sensitive and retains its accuracy in reading through wide ranges of temperature exceedingly well. It can be balanced conveniently and accurately. This type can only be made with the needle movement through a horizontal plane. That is, the axis of rotation must be vertical.

The instrument depends on spiral hairsprings to bring the armature back to zero, and this is one of its disadvantages for use in atmospheres where acid fumes or dust is present.

The two-pivot instrument is made by a number of reputable manufacturers and has proved satisfactory in many installations. The deciding feature in selecting a two-pivot galvanometer instrument is workmanship. Care and thought given to the small details is what makes the difference between a good instrument and a worthless one. The arrangement for balancing the moving element is important. It is proper and customary to balance these instruments in three positions —lying flat on their back, standing up in operating position, and on one side.

Delicate Parts Should Be Protected

Where the pyrometer is subjected to acid fumes and dirt and dust, the suspended type is to be preferred. Protecting cases are a great help, and should ordinarily be used where the instrument is not mounted in a separate, specially built pyrometer room. Even with the best of protecting cases, however, pivoted instruments will get sluggish and become worthless in any atmosphere containing acid fumes or other corrosive fumes, even in relatively small quantities. It is not the pivots themselves that give trouble, as much as it is the fine hairsprings that actuate the moving parts.

The thermocouple is the least expensive part of the pyrometer equipment, and yet it is just as important as the indicating or recording instrument. The thermocouple, it may be said, is the generating part of the apparatus, while the meter merely acts as a receiver to interpret and indicate the message.

The first metals successfully used for thermocouples were platinum and an alloy of platinum and rhodium. This couple is still used for scientific research and for laboratory purposes. The great cost of platinum and rhodium, however, limits the extensive use of them for industrial thermocouples.

Selection of Thermocouples

Much research has been devoted to the discovery of alloys of cheaper metals that would be suitable. Many so-called "base-metal" couples have been devised that are fairly satisfactory.

Certain metals and alloys are unsatisfactory for certain temperature ranges during which they undergo a molecular transformation. Nickel, for instance, cannot be used below 750 deg. F.

The electromotive force or millivoltage developed by a thermocouple is dependent upon the nature of the metals and upon the difference in temperature between the hot junction and the cold end. One of the requirements, then, of a good thermocouple material is that it retain its chemical and physical properties with repeated heating and cooling, and that at a given temperature it will continuously and uniformly generate the same millivoltage.

Some metals become contaminated with impurities much more easily than others, and hence lose their accuracy rather easily and require frequent checking.

It is quite desirable that thermocouples be interchangeable with each other, and this requires that they also develop the same electromotive force at the same temperature. It is therefore, important that all mate-

rial used for making the couples be of very uniform chemical composition.

Certain manufacturers of couples and couple wire guarantee their product to have a definite thermo-electric relation, and this relation is expressed by a curve. The practical significance of this is that if a pyrometer user has couple material of guaranteed millivoltage, he can make up his own thermocouples in his own shop as he needs them.

How to Make a Thermocouple

There is nothing technical or complicated about making up the couples. The positive and negative wires are brought in coils, and to make a couple, it is merely necessary to cut off the desired lengths from each coil, twist them together at one end and weld them with the oxyacetylene flame or other means. Fluorspar or borax is used as a flux. The thermocouple is then ready for use without any tests or adjustments.

Chromel couples generate a very high millivoltage and thus they permit of rugged construction in the meter because of the relatively high potential available. These couples also give practically a straight-line relation between temperature and voltage. This allows the meter-scale divisions to be of nearly equal size and permits easy and accurate readings.

The following brief description of a complete and satisfactory thermocouple might be interesting to the man who would be interested in making his own couples: The two wires forming the couple, after being twisted and welded together, are insulated from each other, from the weld up, by placing porcelain beads over each wire. Double beads are not as satisfactory as the single ones and are more costly. The beads are also superior to asbestos insulation.

As a further precaution against short-circuiting it is sometimes good practice to cut out disks of quarter-inch asbestos lumber to fit the inside of the thermocouple casing and drill these to take the two wires. Space these about every six inches up the thermocouple. In places where the couples receive very rough handling, these spaces keep the wires apart and prevent grounding on the casing even if some of the beads become broken.

Mounting the Couple

A cast-iron bead is recommended for long, heavy-duty couples such as are used in deep furnaces and for high temperature. The cast-iron junction-box should be equipped with a removable cover plate so as to make for easy access to the connections.

Heavy brass binding posts are recommended for the junction-box. These are preferably of the through-going type where the two wires to be connected are pushed through a slot, and the thumbscrew then applies pressure to hold them in good electrical contact.

For the large heavy couples it is also good practice to use a flexible conduit to protect the leads from mechanical injury.

For small couples and for those that are permanently installed in a furnace, the ordinary light pressed-steel bead furnished by the manufacturer is suitable in most cases.

To make certain that the accuracy of the instruments is maintained at all times, it is necessary to make a regular periodic check. In small plants having only a few pyrometers, a simple system of checking only is to be recommended. It is frequently possible to keep the pyrometers in good condition by checking the fire-ends in molten metals. The following table gives the melting points for various metals:

MELTING POINTS OF CHECKING SUBSTANCES[1]

	Deg. F.		Deg. F.
Tin	450	NaCl (common salt)	1,472
Bismuth	518	$BaCl_2$ (barium chloride)	1,742
Lead	621	Silver	1,762
Zinc	786	Copper	1,981
Antimony	1,166	Nickel	2,642

[1]From "Mechanical Engineers' Handbook"—Lionel S. Marks.

This check will tell whether the pyrometer reads correctly at the temperature at which it is checked, but does not give any assurance that it will read correctly at any other place on the scale.

In plants where a number of pyrometers are used, it is advisable to have an easy and dependable way by which the accuracy of the various thermocouples and meters may be periodically checked. The most satisfactory way to do this is to check the pyrometers under service conditions by the use of an accurate test instrument.

The checking thermocouple is inserted alongside the regular couple, or if possible, both couples are placed in the same protecting case. The two meters should then show identical reading at any place along the scale. It is important that both thermocouples be inserted to the same depth in the furnace.

Where extreme accuracy is required in temperature measurement, it is considered good practice to have at least one platinum-platinum-rhodium couple as a standard. Base-metal check couples are then checked against this standard from time to time in the test laboratory. For this work an electric resistance type of furnace is recommended.

For a checking instrument it is the writer's opinion that nothing can compare with the potentiometer type of portable instrument. This type as made by one American manufacturer has binding-post connections for both rare-metal and base-metal couples.

In checking a pyrometer the procedure is to check it as it stands. If the reading is not correct, the thermocouple should first be investigated. If the couple comes up to requirements when used on the standard or checking instrument, it is time to look for trouble elsewhere.

The lead wires should then be examined. All connections or joints in these wires should be soldered and taped to prevent oxidation and corrosion. If the pyrometer is of the low-resistance millivolt type, the resistance of the leads may be very important and any slight change in their resistance would then affect the reading of the meter very materially.

Finally, the meter itself should be inspected for loose connections, grounding and possible rubbing between the rotating element and the polepieces.

The proper balancing of the rotating element is also most important. Where there is no man particularly experienced in repairs on fine instruments, it is recommended that the pyrometer be send back to the builder when badly out of adjustment.

The transmission of heat between a building at 70 deg. F. and outside air at zero varies widely for different parts of the building. Single windows are estimated to transmit 70 B.t.u. per hour; double windows, 40; tar or gravel roofs, 20; slate, tin and shingle roofs, from 26 to 20 B.t.u. per hour. An 8½ in. brick wall is estimated as transmitting 41 B.t.u. per hour; a brick plastered wall, 35; and an 8-in. concrete wall, 37.

Grinding Commutators with Artificial Commutator Stones

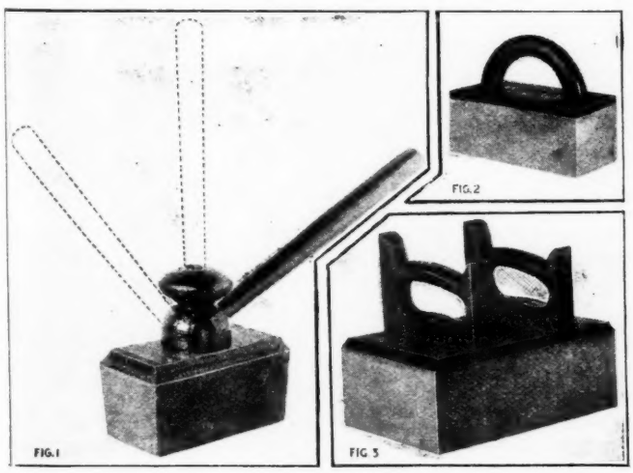
By E. H. MARTINDALE
General Manager, The Martindale Electric Company

Describes briefly the process of manufacture, shows the proper method of using commutator stones, precautions to take when using them, and treats briefly the machine troubles which make frequent grinding necessary

GRINDING commutators with special blocks of abrasive material held against the commutators by hand has grown rapidly during the last few years. The annual market for artificial commutator stones now exceeds $150,000.

The material from which these stones are made is first vitrified in an electric furnace. It is then crushed in such a way as to leave the particles in a semi-crystalline state with very sharp edges and then separated through screens into the various sizes required for the different grades. The material is mixed with a binder, packed into molds, allowed to stand for a short time, placed in a gas furnace and baked. After the blocks have been baked and have passed an inspection, they are usually fitted with some convenient handle, of which three types are illustrated in Figs. 1, 2 and 3.

The action of commutator grinding with an artificial stone is entirely unlike the action of a grindstone. In the latter case the particles of the object being ground are torn from it by the grindstone. When such a grindstone is used on a commutator, it clogs up with copper and will usually pull the copper at the edges of the bars, and on slotted commutators will sometimes pull the copper across the slots. The action of the artificial stone depends on the rolling of the particles between the surface of the stone and the commutator after they have been torn loose from the stone. This necessitates a rapid wear of the stone, but at the same time insures rapid cutting and freedom from clogging and the edges of every bar are cut clean. The greatest efficiency is obtained after the stone has worn to a full face. Also, the longer the stone is the more cutting is secured from the same amount of material, for the reason that it rolls farther before escaping.



FIGS. 1 TO 3—DIFFERENT FORMS OF ARTIFICIAL COMMUTATOR GRINDING STONES

Proper Sizes and Grades of Stones

A commutator stone should be as long as will work freely between adjacent brush sets and should also be twice as long as the width of the largest flat spot. This latter requirement may occasionally make it necessary to remove one brush-holder stud during the grinding. The stone should be considerably narrower than the commutator, so that it may be moved slowly from side to side during the grinding to prevent ridges from wearing grooves in the stones. The headpiece is a good illustration of the proper relative size of a commutator stone and commutator.

Where much copper is to be removed, it is usually more economical to do the heavy cutting with a coarse-grade stone and finish the commutator with a fine-grade. Where only high mica or a small amount of copper is to be removed, the fine grade is sufficient.

Grinding stones have many advantages over other methods of truing up a commutator. The commutator is operated at full speed and frequently at full load during the grinding, as for example on elevator motors. Thus the centrifugal force holds every bar in its true operating position.

On the other hand, when a commutator is turned with a turning tool, if any of the bars are less firmly gripped by the V ring than others, they will be pushed in slightly. When the commutator is brought up to full speed, the centrifugal force will throw these bars out slightly, resulting in a high bar usually followed by a flat spot just back of the defect.

Grinding a commutator usually takes less than one-tenth of the time required to remove an armature, take it to the shop, turn the commutator and get the machine back into service. The returns from a questionnaire sent out to more than 1,500 users showed a saving of from three to more than twenty times the cost of the stones with an average saving of six times the cost, over removing the armature and truing the commu-

tator in a lathe. An even greater saving, which is not included in this figure, is effected by the elimination of a flat spot as soon as it appears instead of the former practice of letting the spot grow until the machine begins to give serious trouble.

After a flat spot appears, it will grow rapidly and in a short time it may be necessary to take off $\frac{1}{16}$ to $\frac{1}{8}$ in. of good commutator to remove the one spot. A commutator stone is so easy to apply that it can be used as soon as the flat spot appears, when it may be eliminated by the removal of only a few thousandths of an inch of copper.

Directions for Using Commutator Stones

If grease or oil is present, wipe or sandpaper the commutator thoroughly before applying the stone, because oil will interfere with the cutting and often cause the stone to clog with copper.

Run the machine at full speed.

Do not rock the stone; hold it firmly in order to get a true arc as quickly as possible.

Apply with sufficient pressure to get rapid cutting. From two to four pounds per square inch of cross-section will usually give good results.

If the stone wears faster on one side than on the other, it is because the pressure is not applied perpendicularly. The effect may be corrected by turning the stone three or four times until the full face has been obtained.

During grinding move the stone slowly from side to side. This will prevent ridges in the commutator from wearing grooves in the stone. Large stones which are difficult to move while grinding may be held in one place for a few seconds, then lifted, moved about $\frac{1}{4}$ in., applied again for a few seconds, moved again and so on until the commutator is true.

Progress toward a smooth and true commutator can be ascertained by feeling the brushes with the finger or by shutting down the machine and examining the surface of the commutator. If the stone has been correctly applied, the grinding is finished as soon as every bar is clean.

The wear of the brushes during grinding, due to the rough commutator, is usually negligible except on large machines, where from one to three hours may be required to complete the grinding.

If the brushes have been removed during grinding, they may be replaced and allowed to rebed themselves on the rough commutator before the finished grade is applied. This beds the brushes quicker and much better than can be done with strips of sandpaper.

Cleaning the Machine After Grinding

After the grinding is finished, it is good practice to wipe off the commutator, lift the brushes and wipe off their faces, and if compressed air, a portable blower or hand bellows is available, blow out the machine thoroughly. Many companies do not take these precautions, and so far as the author knows no trouble has resulted, but he considers it advisable to do so whenever possible.

In addition to the precautions already mentioned, it is well to caution the operator in regard to breathing the dust thrown off by the stone. It is no more injurious than other dust, but it irritates the throat and lungs and makes the operator more liable to catch cold. The air currents may be such that the dust is carried away from the operator, but if not, it is advisable to tie a handkerchief over the mouth and nose or cover the nostrils with a thin layer of cotton and breath through this.

Machine Defects that Necessitate Grinding

Grinding is done to remove flat spots, ridges, high bars or high mica. It is to be expected that these troubles will occur at times without any inherent trouble in the machine, but the recurrence of any of them within a short time after grinding calls for further search for the seat of the trouble.

High Bars—A high bar indicates a loose commutator. The commutator should be tightened while the machine is hot and should then be ground.

Ridges—Ridges may be formed at the inner and outer edges of the commutator and between brushes unless they are properly staggered. Brush-holder studs should be staggered by pairs; that is, the brushes on one pair of positive and negative studs should operate in one track, the next pair in a different track, and so on around the machine.

If ridges form rapidly, attended by a bright commutator surface, it is due to the abrasive action of the brushes. If less abrasive brushes may be used without resulting in high mica or a black commutator, they should be applied. If ridges are formed rapidly, attended by a black commutator, it is due to burning or sparking which may be caused by low brush pressure, insufficient abrasive action of the brushes or the causes of sparking, which will be dealt with under flat spots and high mica.

Flat Spots—Flat spots are caused by sparking which occurs repeatedly at the same point on a commutator; the following are the most common causes:

Brushes tight in the holders, preventing their free movement to correspond to any slight irregularities of the commutator.

High bar lifting the brushes from the commutator enough to produce a slight arc.

Eccentric commutator at high speed throwing the brush from the commutator slightly as the highest point passes under the brush.

Difference in hardness of commutator bars or mica. This applies more particularly on repaired commutators where new bars or new mica strips have been added. The best remedy is to undercut the mica and use non-abrasive brushes.

Loose connections between coil leads and commutator bars, which produce anything from very slight to very vicious sparking, depending on how loose the connections are. This is one of the most common causes of flat spots.

Open-circuit in armature coil, which is similar to a loose connection but more severe in its action and usually causes pitting of the mica between the bars connected to the ends of the defective coil.

High Mica—If the mica of a commutator is not undercut, any form of sparking tends to burn away the surface of the commutator bars leaving the mica high. This condition prevents the brush from making good contact with the bars and increases the sparking, which in turn increases the burning of the bars, and the commutator goes from bad to worse rapidly.

The most frequent causes of high mica in addition to those mentioned under flat spots, are as follows:

Low brush pressure or failure of brushes to work freely in the brush-holders, causing poor contact between the brushes and the commutator.

Brushes not operating at the neutral point, permitting short-circuit currents in the brush faces.

Brushes not spaced correctly around the commutator, throwing part of them out of the neutral zone, permitting short-circuit currents in the faces of these brushes.

Unequal air gaps caused by poor assembly or by worn bearings, which permit the armature to run closer to one field face than to another. This causes an unequal generation of power in the armature coils with an unequal distribution of current in the brushes.

Chattering of brushes or severe vibration of the entire machine, which throws the brushes from the commutator or lifts them sufficiently to cause poor contact.

To sum up, whenever high bars, ridges, flat spots or high mica recur at frequent intervals, it is advisable to make a thorough search for the seat of the trouble. An ounce of prevention is worth a pound of cure.

Overheating of Oil-Engine Pistons

By H. F. Shepherd

While engaged in a series of experiments to determine the effect of pressure upon scavenging efficiency, the writer was at one time very forcibly impressed with the fact that the exhaust temperature closely indicates the success or failure of a given system. This suggested the thought that the exhaust temperature should bear some mathematical relation to the actual scavenging efficiency.

A scavenge pump, it will be understood, under fixed conditions delivers to the cylinder a certain weight of air each cycle. If there were no overflow to the ports, either direct or by the entraining of the fresh air with the outflowing exhaust gases, the system might be regarded as 100 per cent efficient. It was observed that conditions such as to cause excessive port loss brought about a rise of exhaust temperature. By analysis of the expansion line it was found that this rise was not due to afterburning occasioned by insufficient oxygen. In fact, the rise of exhaust temperature with deliberate misuse of the scavenging air available was quite as marked at friction load when a great excess of oxygen is present.

The exhaust temperature recorded at the engine could not be used for a strict analysis of this condition since much heat, accounted as jacket loss, is lost actually during the exhaust period. The exhaust thermometer aside from this indicates only the mean of a variable temperature. The value of its readings as a guide is a relative and not a finite one.

Accordingly, we carefully calculated the ratios of the expansion-end temperature and the temperature of the residuals after release, to the initial or charge temperature for a diagram correct to practice. A volumetric efficiency for the scavenge pump was then determined and the theoretical exhaust temperature calculated under conditions: (1) If all the air were retained and (2) if only a quantity or percentage (x) of the air were retained, the balance mingling with the exhaust.

Somewhat to our astonishment the theoretical exhaust temperature for any given mean effective pressure worked out exactly the same regardless of the value of x. This brought the case into the clear. It may be covered by a very simple statement: With a fixed quantity of air delivered by the scavenge pump each cycle, an exactly equal weight of residuals must escape the exhaust ports (it is not necessary to include the fuel gas weight in this discussion). The heat loss to exhaust is fixed by the nature and actual efficiency of the cycle and mean effective pressure. Therefore for a given m.e.p. a fixed weight of air bears away at each exhaust a fixed quantity of heat measured by the rise of temperature above the air source. One should expect, then, a constant exhaust temperature as long as the cycle remains unchanged, regardless of any variation in scavenging efficiency.

However, operative results are not in accord with this theory, so, if not incorrect entirely, the theory is at least incomplete.

The one condition that could operate to vary the exhaust temperature with other factors fixed, would be the addition of heat from some source other than the fuel charge for the immediate cycle. The only possible source of such heat is waste heat from some previous cycle unaccounted for by the jacket and exhaust loss, and the failure of practice to conform to the theory outlined is explained.

With inefficient scavenging the charge temperature is increased. So also is the terminal temperature and the temperature after release and expansion to atmospheric pressure. The latter temperature, however, is not the exhaust temperature for a two-stroke-cycle engine. The latter is determined by the residuals at the temperature existing after expansion to atmosphere pressure and the weight of fresh air at the temperature of source that escapes at the ports as a diluent, reducing the exhaust temperature to its true theoretical value.

Heating of the Air Charge

Certainly, with part scavenging the charge temperature is increased, and as the mean cyclic temperature bears a fixed ratio to the charge temperature for a given m.e.p., it is raised proportionally. This in turn causes a greater loss of cyclic heat, due to increased absorption by the walls. The walls store this heat and emit part of it to the next charge, causing a further rise with further increased absorption and emission cycle after cycle by some rate of progression depending on too many variables to be worked out as a practical problem.

With an increased charge temperature there is not necessarily an increase of wall heating. The conduction of a greater quantity of heat requires a greater gradient through the walls, but the differential may be established by operating with cooler jackets. The jackets, therefore, provide for the head and cylinder, but the influence of the uncooled piston head must be considered. Heat is collected all over the piston-head surface and is dissipated radially and longitudinally through the metal to the rings and barrel. Thence it is conducted by contact to the cylinder walls and jacket. The temperature gradient of an uncooled piston head under normal full-load conditions is high, as anyone knows who has seen a piston working at nearly red heat in the center and yet cool and successfully lubricated at the circumference.

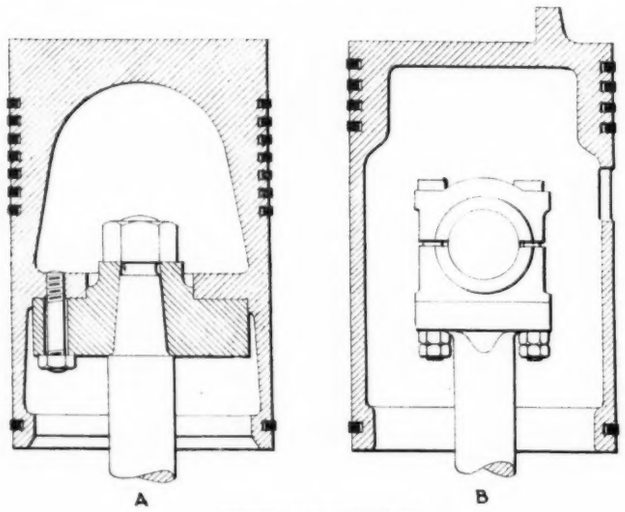
This gradient will increase in ratio to the quantity of heat to be dissipated, which, in turn, is a function of the mean cyclic temperature.

A two-stroke-cycle engine piston need not run hotter than that of a four-stroke-cycle engine. The mean

cyclic temperature is naturally lower in a four-stroke-cycle engine, but if the piston head is made thicker for the two-stroke-cycle unit in proportion to the greater quantity of heat that it has to dissipate, the temperature gradient through the metal may be just the same.

During compression the influence of piston radiation will be the same in either type. During explosion and expansion the temperatures lie mostly above the mean so there can be no great emission of heat from the walls to the cylinder contents. During suction the new charge is exposed to the piston-head heat and therefore, in the four-stroke-cycle engine the piston gives heat to the air charge during a period of time equal to one stroke-interval. In the case of the two-stroke-cycle engine pumping its scavenge charge within the piston, the air charge is under the influence of the piston heat for a time equal to at least two stroke-intervals.

Aside from this difference there is another serious influence to consider. In the ordinary one-to-one scavenge system no receiver is used, the clearance in the crankcase or open end of the cylinder determining the maximum pressure and acting as storage. Considering a case in which the scavenge pressure is 20 lb. absolute, the volume ratios are approximately 1.25, and $V_1 - V_2 = 0.25\ V_2$. The stroke volume is then 0.25 of the clearance volume, making the former 0.2 of the free air volume.



TYPES OF PISTONS

The volume of free air, held more or less under the influence of the heat conducted through the piston and emitted on the crank side, is five times the effective piston displacement. In short, the air charge is not only under heat influence for one whole revolution previous to entering the main cylinder, but if at all turbulent it may suffer this influence for the time of five revolutions before transferring. Unfortunately, accurate measurements of temperature in the transfer port are not possible on account of the fluctuations in pressure. Temperatures up to 125 deg. F. have been encountered in good commercial engines and this value is often greatly exceeded in bad-working engines.

Every experimenter has encountered the condition of a rising exhaust temperature under a fixed load. If the engine works normally, the exhaust thermometer will show a gradual rise after starting, taking fifteen minutes to one hour to reach its constant value for the load carried. If, however, the exhaust temperature climbs and continues to climb, first black smoke shows in the exhaust and if care is not exercised a dry cylinder or perhaps a seized piston results. Pistons have been melted through the center under such operation.

Unfortunately, the heat emitted from the piston-head surface to the air charge varies as the fourth powers of the mean temperature of the radiating surface and of the temperature of the air charge. The heat dissipated through the piston metal to the cylinder walls and jacket follows the law of conduction to which the law of direct ratio applies. Therefore, once the piston receives heat a little beyond its ability for heat dissipation, its temperature rises rapidly and its emission to the air confined within it increases at a far greater rate than its conductivity. Cumulative heating proceeds from this point. Once equilibrium is past, the process of piston heating becomes regenerative and the limit of rise is set only by the ability of the engine to work at all under evil conditions.

Any good commercial engine should deliver its rating under proper exhaust conditions, with a constant exhaust temperature as the indicator of no progressive heating. Favorable exhaust conditions are rather the exception than the rule, so the ability of an engine to endure bad management in this direction is measured by the overload that it will carry without progressive heating. If such heating sets in a little beyond rating, the engine must be installed and operated with great care. If it will carry a fair overload with no piston heating, after operating at a fixed exhaust temperature hour after hour, it is in no danger.

Avoidance of Piston Heating

This leads to the piston design. One cannot give a better example of its kind than the piston shown at *A*, Fig. 1. Note the many rings, for rings after all are the best carriers of heat. Note the broad path for conduction of heat to the rings and barrel. The closed cavity below the crown also keeps the scavenge air away from the hot piston bottom. Further, there is no air deflector on the piston. There is possibly no worse evil than a hot deflector. The air passing at storm velocity over the hot surface of the lug will wipe off quantities of heat as evidenced by the fact that the hottest area of a two-stroke-cycle engine piston always lies off center and away from the inlet ports.

Possibly the most foolish proposal is that of cooling the piston and wristpin by passing the scavenging air through the piston as illustrated in Fig. 1*B*.

The writer has used oil-cooled pistons on 16-in. bore two-stroke-cycle non-water injection oil engines with splendid results. These engines operate side by side with similar engines using dry pistons, and the improvement in cylinder life and operating characteristics as well during three years of service has been such as to make a strong case for the more complicated engine. This brings home the fact that the boasted simplicity of the solid-injection engine is often only incompleteness attained by dispensing with equipment required by a good Diesel engine. One might say that the two-stroke-cycle solid-injection engine of today would be the better for separate scavenge pumps for reasons well developed in this discussion.

Finally, with properly cooled pistons and separate scavenge pumps, much of that mystery that heretofore has made it impossible to design two-stroke-cycle solid-injection engines of the semi-Diesel type with exactly the same factors regardless of size would disappear.

Operation of Over-Speed Governors on Electric Elevators

Comparison of the Different Types of Elevator Governors and the Advantages and Disadvantages of Each

By HOWARD B. COOK
Engineering Department, Warner Elevator Manufacturing Company

IT MIGHT seem that the overspeed governor on an elevator is a rather unimportant part of the equipment. It performs no service in normal operation and it may not be called upon to act during the life of the elevator. The governor is the safety valve, it is the court of last resort. If the other safety devices, such as the car switch, emergency switch, mechanical brakes or dynamic brake, should fail to prevent excess speed or if the cables should break, then the governor would be called upon, first to open the potential-switch magnet-coil circuit and then to operate the governor rope grip.

It is evident that reliability is of first importance in the operation of the governor. The design must be such that wear or rust will not prevent operation at a critical time. It must be sensitive to overspeed yet it must be stable so that accidental operation will not occur. The design should be such that normal speed will cause a slight movement of the weights. This will indicate that the weights are free to move, and this is also useful in observing whether the elevator is operating at the proper speed.

Adjusting Governor Switches

Where governor switches are used it is customary to adjust the governor so that an excess speed of 20 per cent will operate the switch. The opening of this switch will release the potential switch and cause the machine to stop by the cutting off of the current to the motor and the application of the magnetically operated brakes. If the car continues to increase in speed, the governor will operate the rope grip at 40 per cent overspeed. These percentages are arbitrary and should be reduced if it is possible to do so without causing the governor to act on account of the normal variations in speed.

The governor rope grip *G*, Fig. 1, must stop the governor cable so that further descent of the car will cause the cable to be pulled loose from the releasing carrier on the car and the unwinding of the safety cable from the safety drum under the car. This action will engage the safety device. The continued descent of the car will continually increase the pressure of the safety jaws against the guides, and it is possible that this force might become so great that some part of the safety device would be overstrained before the car would be brought to rest. To obviate this danger, the governor rope grip is provided with a spring *S* that will permit the governor rope to slip after a sufficient force has been applied to stop the car, but before any part of the safety mechanism is overstrained. The rope grip must in any case be sufficiently strong to pull the governor cable loose from the releasing carrier on the car. The tension necessary to slip the cable varies with the design of the safety device and the capacity of the elevator. It is seldom less than 300 or more than 1,200 pounds.

The earliest governors used on electric elevators were of the vertical shaft flyball type, shown diagrammatically in Fig. 1. The design was probably borrowed from the steam-engine practice of that day. The horizontal-shaft governor, one type of which is shown in Fig. 2, is coming into wide use on elevators in present-day practice and this type has several advantages, chief of which is simplicity. The vertical-shaft

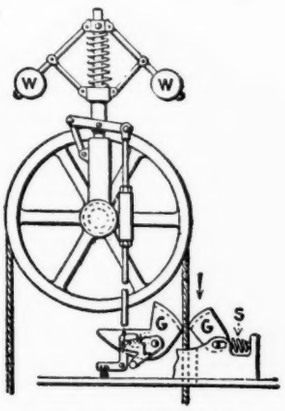


FIG. 1—VERTICAL SHAFT TYPE GOVERNOR

FIG. 2—HORIZONTAL-SHAFT TYPE GOVERNOR

type must be geared, usually with bevel gears, and wear often causes the gears to become noisy.

There is, practically, but one moving part in the horizontal-shaft type, and with proper design all the desirable characteristics of the vertical-shaft type can be attained. The geared governor has some advantages on slow-speed elevators where, as will be shown later, the centrifugal forces available on the direct-drive type may not be sufficient to overcome the friction resistance, but many of the governors in use on slow-speed elevators are of the direct-type, while many in use on high-speed elevators are of the geared type. The governor is generally operated by a ¼-in. iron or steel cable running on a sheave that is usually 16 in. in diameter for high-speed service.

At low speeds the centrifugal force tending to move the weights *W* is very small, but increases with the square of the speed. The force in pounds can be obtained from the equation $F = \frac{WV^2}{gR}$, where *W* is the weight in pounds of the governor balls, *V* the velocity of the center of gravity of the weights in feet per second, *R* the radius or distance in feet from the center of rotation to the center of gravity of the balls, and *g* the acceleration of gravity, or 32.2.

Assume an elevator speed of 600 ft. per min. If the governor sheave is 16 in. in diameter, it will have a speed of 143 revolutions per minute, or 2.4 revolutions per second. If the distance of the center of gravity of the balls from the center of rotation is 6 in., or 0.5 ft., the effective velocity of the weights at 2.4 revolutions per second will be $2.4 \times 3.1416 = 7.5$ ft. If the combined weights of the balls is 8 lb., the centrifugal force will be $F = \frac{8 \times (7.5)^2}{32.2 \times 0.5} = 28$ lb. At a car speed of 300 ft. per min. the force would be 7 lb., at 150 ft. per min. 1.75 lb., and at 75 ft. per min. 7 oz. It is apparent that at low speeds the centrifugal force would scarcely be sufficient to overcome friction and insure dependable operation. Reduction of the sheave diameter would increase the speed of rotation and thereby increase the centrifugal force available. This reduction would be justified because a slow-speed elevator does not travel many miles in a day and the rope life would be long even though the relative life would be shortened.

In the vertical-shaft type the governor balls are in static balance in all positions; in the horizontal-shaft type the individual weights are only in static balance in two positions. It is necessary to connect the two weights together with a suitable linkage so that the unbalance of one weight will compensate the unbalance of the other and thereby keep the weights in static balance in all positions.

Some governors of the horizontal-shaft type are made without a connecting link between the weights, but the spring tension must be sufficient to overcome the effect of gravity in addition to the centrifugal force at normal speed. Such governors require an excessive speed for their operation and their use should be discouraged. It is difficult to adjust some types of governors on account of friction, because the connecting link between the two weights is attached close to the supporting pin. Under these conditions the pressure on the pins at the ends of the link is several times as great as the weight of the balls. Moreover, this force is also impressed on the pins that support the balls. In some cases the spring pressure is carried through the connecting link and tends to increase the pressure on the weight pins. It is possible to arrange the connecting link so that the unbalance of the individual weights does not impose a heavy pressure on the supporting pins, and when the spring is connected directly between the two weights, the friction that would, under other conditions, oppose the movement due to centrifugal force, is reduced to a minimum and closer regulation can be attained.

When the governor balls move out due to centrifugal force, the radius of the center of gravity increases and the centrifugal force increases because of the greater velocity due to the greater radius. If the spring pressure does not increase at a greater rate than the centrifugal force, the weights will move out to the limit of action without any increase in the speed of rotation. Under these conditions the rope grip will be operated together with the governor switch whenever the critical speed is exceeded. To stabilize the governor and cause the weights to move out gradually with the increase in the speed of rotation, it is necessary to so proportion the spring that its reaction will increase more rapidly than the centrifugal force.

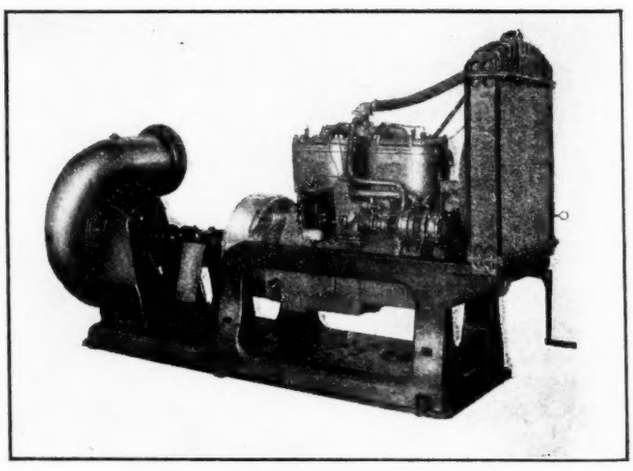
Inertia is another factor that must not be ignored in the design of a governor. Steam engineers who are familiar with the principle of the "Rites" inertia governor know the effects produced when a load is suddenly applied to a steam engine equipped with this device.

When the governor weights are supported on pins that have their axes parallel to the governor shaft, a sudden start produces a tangential force that will tend to assist the centrifugal force and cause the governor to act more quickly or at a lower speed than would be the case if it were accelerated slowly. This action might seem to be valuable in causing the governor to act more quickly in case of a falling car. Sudden starts are, however, common in normal operation, and in governors of this type used on slow-speed elevators, the effect of inertia due to normal starts may be several times as much as the centrifugal force at normal speed. Under these conditions it would be necessary to tighten the governor spring so that a great excess in speed would be necessary for operation if the overspeed were attained at a low rate of acceleration.

Rates of acceleration equal to one-fourth of gravity are not uncommon in elevator service, and a sudden start of this value would produce a force equal to one-fourth the weight of the governor balls. In most designs of this type only a part of this force would tend to cause the governor to act, depending upon the radius of action of the center of gravity of the weight and the distance of the supporting pin from the center of rotation. The effect of inertia is entirely neutralized in the vertical-shaft governor because the supporting pins are set at right angles to the axis of rotation. This is also true of the horizontal-shaft governor when the weights are supported in the same relative manner.

Gasoline Engine Pump Unit

The Clinton Engineering Co., Clinton, Iowa, has developed a medium-speed four-cylinder gasoline engine for direct connection to centrifugal pumps. As shown in the illustration, the engine cylinders are cast in pairs, as are the cylinder heads. The water-cooling system consists of a radiator and centrifugal pump, together with a thermostatically operated bypass by which a uniform jacket temperature is maintained.



GASOLINE ENGINE PUMPING UNIT

This engine is also arranged for connection to underwriters' fire pumps and for belt drive for general industrial purposes.

Characteristic Curves of Centrifugal Pumps

By RUSSELL K. ANNIS

EFFICIENCY—that abstract but important measure by which a pump is judged—is obviously not of any value unless it is attained. And the attainment depends largely upon another and much more slighted attribute, the characteristic curve. This is the curve showing the head plotted against the capacity and is sometimes called the head-capacity curve.

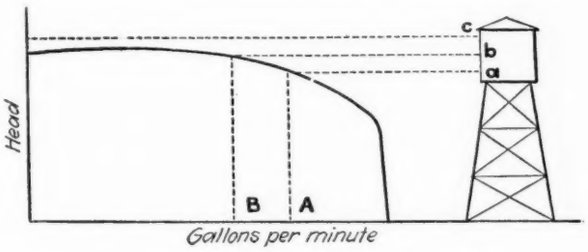


FIG. 1—PUMP WILL NOT FILL TANK

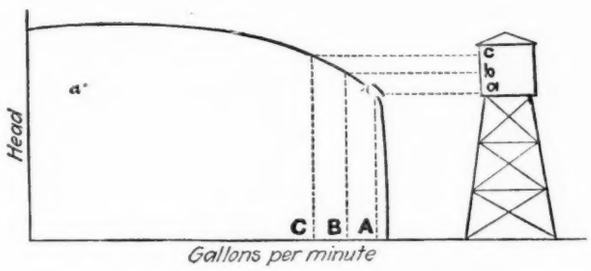


FIG. 2—CAPACITY DANGEROUSLY HIGH

When a centrifugal pump is to be installed, it is always wise to consider not only the simple question as to whether it will meet the normal conditions for which it is intended, but also the performance that can be expected when the conditions vary from the normal. This is the best way to get smooth flexibility throughout the plant. Irregularities of all kinds are bound to occur, and the best way to meet them with any equipment is to have that equipment so designed that the units will be properly co-ordinated with one another. In a steam engine this lack of co-ordination between the engine and the governor is called hunting; in a dynamo it is called voltage regulation or speed regulation; in a centrifugal pump there is no commonly recognized term, but the same unbalanced condition can exist, and this unbalanced condition or quantity regulation is not due to any intrinsic fault within the pump, but to a lack of balance between the pump and the adjoining apparatus. It is to avoid this unbalanced condition that the characteristic curve of a pump should be studied before making an installation.

Flat and Drooping Curves Compared

A convenient method of representing a curve together with the head against which it is to pump is shown in Fig. 1. The water tank is drawn in on the curve sheet to the same scale as the curve, and in this way a horizontal line drawn from any point on the tank will intersect the curve at a point that indicates the rate of discharge. In Fig. 1, when the tank is filled to the point *a*, the pump will be delivering at the rate of *A* gallons per minute. Likewise, when it is filled to the point *b*, it will deliver *B* gallons per minute. But if the water rises to a point *c*, above the curve, there will be no water pumped at all. This comes from the curve's being too "flat."

The curve in Fig. 1 is called a flat curve because the greater portion of it lies approximately in a horizontal line. The distinction between a pump having a flat curve and one having a drooping curve is not always a sharp one, and thus many curves can be plotted so as to indicate either classification. A pump having a moderately drooping curve can be plotted with the capacity ordinate to a large scale, thus extending the curve in a horizontal direction, and with the head ordinate to a small scale making the shape quite flat. Likewise, exaggerating in the other direction will make it appear distinctly drooping. Almost any drooping curve starts off flat, and any flat curve finally falls off to zero. This would make it appear that there is no real difference between them, but this disarrangement can be accomplished only with pumps between the two conditions.

The important feature is the shape of the curve at and near the point at which the pump operates. A curve would certainly be called drooping where a 10 per cent decrease in head causes a 10 per cent increase in the rate of discharge. Also, a curve is distinctly flat where it is tangent to a horizontal line. Between these two conditions the engineer must use his judgment according to the kind of service for which the pump is intended.

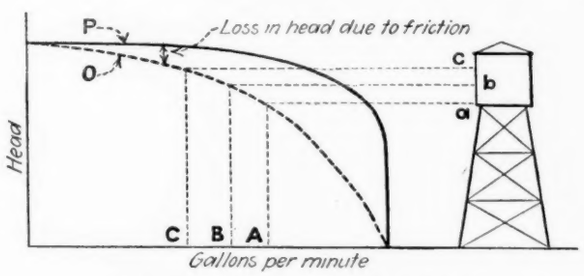


FIG. 3—EFFECT OF THROTTLING

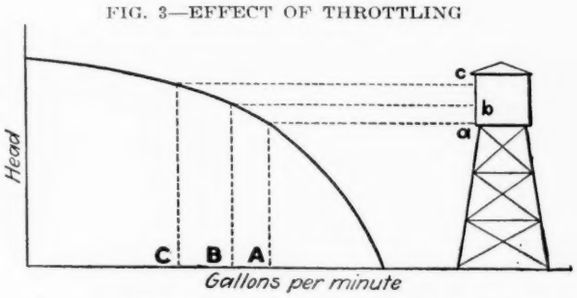


FIG. 4—TANK PUMP HAVING A DROOPING CURVE

Referring again to Fig. 1, it was explained that there would be no discharge when the tank is filled to the point *c*. Fig. 2 shows how this is usually overcome. This curve is similar to the curve in Fig. 1 except that the head has been increased by furnishing the pump with an impeller of a slightly larger diameter. At once another difficulty is encountered. The increased head makes it possible to get water at the point *c*, but when the level is lowered to the point *a*, the rate of delivery

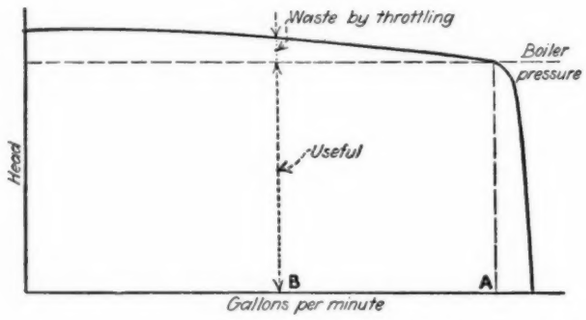


FIG. 5—FLAT CURVE BEST FOR BOILER FEEDING

is increased beyond normal, and this usually produces overloading of the prime mover and also a decreased efficiency. This is a vital point and one not generally understood, in that lowering the pressure against which the centrifugal pump acts has increased the horsepower required. This is a thing that gives more trouble with tank pumps than with pumps doing any other class of service.

By increasing the diameter of the impeller, we have stepped out of one trouble and into another. We have raised the head to include the point *c*, but we have overloaded the motor at point *a*. The question now arises as to how to prevent the overload on the prime mover. The usual thing is to throttle the pump. Put a gate valve in the discharge line and adjust it so that the horsepower is normal when the tank level is at its lowest point. The head at the pump is thereby increased by the amount of the friction, as shown in Fig. 3, and also, when the level rises to the point *c*, the rate of discharge is still good. This entire procedure will give quite good results. The only bad feature is that the power thrown away in the friction of the gate valve is lost. However, it is the best that can be done with a pump having a flat curve and not required to operate at its maximum capacity. Of course there is the alternative of supplying a larger motor, but this is not usually considered economical.

It is evident from this that a flat curved pump is not strictly suited to tank service. In fact, by the method given, we have increased the diameter of the impeller and then throttled the pump, thereby producing not a pump with a drooping curve, but a pumping outfit with a drooping curve, considering the pump and throttle valve as a unit. In other words, the curve *P*, Fig. 3, represents the curve of the pump the same as in Fig. 2, while the curve *O* represents the complete pumping unit.

This brings up another point. A pump can be designed to give the resultant curve of Fig. 3, and this pump will not be subject to the friction losses that are imposed on the flat curved pump. It also has the advantage that no adjustment of a throttle valve is required, and hence it cannot get out of adjustment. The curve of such a pump is shown in Fig. 4. This curve droops the same as the frictional curve of Fig. 3, but because of the fact that the low head is due to the design of the pump instead of wasted power, the efficiency of the outfit is unimpaired.

To the pump user this means, for tank service, use a pump with a drooping curve and save power and annoyances. To the pump designer it means, have more than one impeller for each size of pump so that an impeller can be selected that will not only fit the customer's requirements, but also give him that flexibility which is so necessary to the operating engineer.

Boiler-Feed Pumps Should Have Flat Curve

That a flat curved pump is best suited to boiler-feed pumps is illustrated in Figs. 5 and 6. Boiler feeding requires a pump that operates against a head that is practically constant, depending on how accurately the boiler pressure is held at a definite point. Also, the rate of delivery is going to be varied to suit the demand on the boiler. Unless the speed of the pump is variable, which is not generally the case, this variation in delivery is controlled by means of a gate valve, and it is best to effect this control with as little friction loss as possible. As all pressure developed by the pump in excess of boiler pressure must be used up in the friction of the throttle valve, a pump should be used that will give as little increase as possible in pressure when the rate is cut below normal.

Fig. 5 shows a good curve for boiler feeding. At *A* the boiler and pump are at maximum capacity. It is well, though not necessary, to have the capacity of the pump slightly in excess of this in order to raise the water level in the boiler when required. The dotted

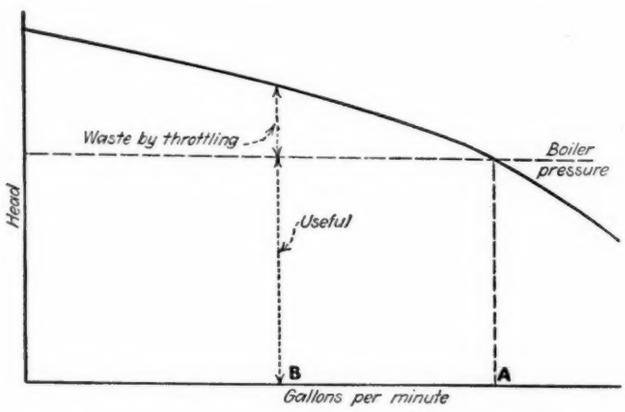


FIG. 6—WASTE OF POWER INCURRED BY TOO STEEP A CURVE

line shows the boiler pressure, and the point in which it intersects the characteristic curve of the pump gives the maximum number of gallons per minute that the pump can deliver to the boiler at full boiler pressure. At reduced loads it becomes necessary to throttle the pump as at *B*, which causes a loss of power in the form of friction. As this loss is represented by the vertical distance between the curve and the boiler pressure line, it is evident that it will be a minimum with a flat-curved pump. Fig. 6 shows the same conditions of capacity and pressure using a pump with a drooping curve. Here the results are the same as long as the boiler is at full load, but when the load falls off and it becomes necessary to throttle the pump, the frictior

loss in the throttle valve becomes much greater than that of the flat curved pump. This goes to show the importance of having a pump not only suited to its normal requirements, but also adaptable to any condition within the range of the apparatus to which it is supplementary.

Large Capacity Desirable in Circulating Pumps

This class of service is almost the exact opposite to tank filling. In tank service we usually find a high static head and very little friction head. In circulating service there is usually no static head at all and sometimes a very high friction head. A circulating pump may be considered to be always "throttled," not by a valve, but by the pipe lines and coils through which it pumps. This throttling action is almost a guarantee against motor overloads, and therefore the flat-curved pump will give no trouble from that source.

In Fig. 7 the characteristic curve of the pump is represented by the curve *B*, while the pressure required by the circulating system at varying capacities is represented by the parabolic curve *A*. The point where these two curves cross represents the gallons per minute that may be expected to flow.

As large capacities are usually desirable in a circulating system, a pump having a flat curve will give better results than one having a drooping curve. The preference, however, is very slight, and good results may be expected from either. The flat curved pump will probably be a little more efficient. Fig. 7 shows a flat curved pump, and Fig. 8 shows a drooping curve.

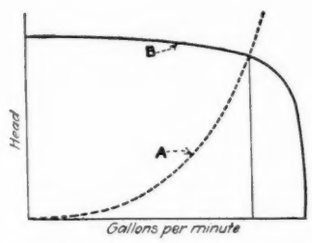


FIG. 7—FLAT CURVE BEST FOR CIRCULATING PUMPS

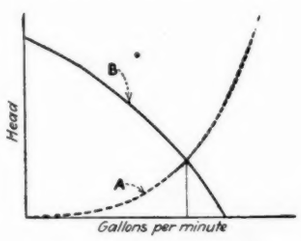


FIG. 8—CAPACITY REDUCED BY DROOPING CURVE

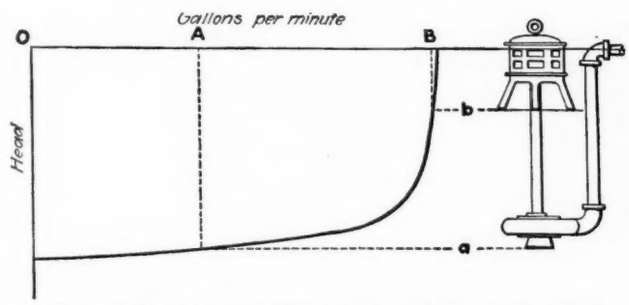


FIG. 9—SUMP PUMP WITH FLAT CURVE (INVERTED)

Assuming that both pumps have the same diameter of impeller, as the curves show, the shut-off pressure will be the same in either case, and the intersection which determines the rate of delivery will occur farther to the right on the flat curve than on the drooping curve. This shows a higher number of gallons per minute.

The vertical sump pumps or bilge pumps around a plant are too frequently installed without enough study, on the ground that they are small and not worth the attention required. However, they can give almost as much trouble as a larger unit, and are certainly worth the time to inquire into the shape of the characteristic curve. The curves shown in Figs. 9 and 10 are inverted in order to show them together with the pumps. In other words, the line of zero head is placed at the discharge level, so that the suction level will indicate the rate of discharge when the sump is empty.

Fig. 9 shows a sump pump having a flat curve. The normal working conditions are such that, when the

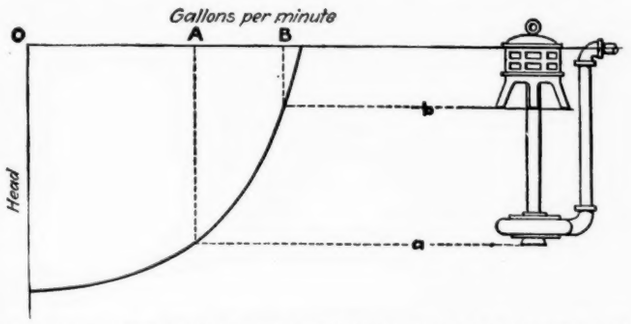


FIG. 10—SUMP PUMP WITH DROOPING CURVE (INVERTED)

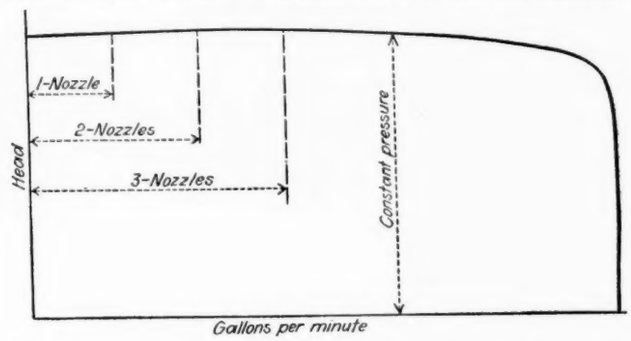


FIG. 11—CURVE OF FIRE PUMP OR PRESSURE BOOSTER

water level is lowered to *a*, the pump will deliver *A* gallons per minute. This discharge rate must necessarily be greater than the rate at which the sump is being filled, and therefore the motor's rating is based on this condition. However, when the sump fills to the point *b*, the rate of discharge will increase to *B* gallons per minute, and the motor will be overloaded. If the pump were selected so that at this head its capacity were equal to the rate at which the sump is filled, it is evident that the level would never be lowered below this point, and the pump would be required to run continuously at a great loss of power.

It is better to use a pump with a drooping curve, as shown in Fig. 10, with the normal rating at *a*, the same as in Fig. 9. Then the decrease in head as at *b* can be provided for with a much smaller motor than with the same condition in Fig. 9.

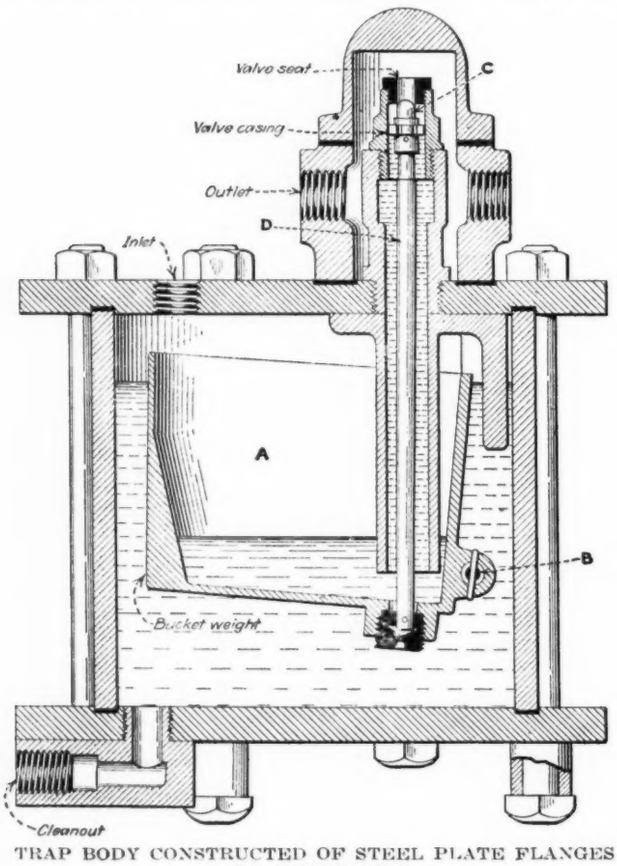
Under these headings of booster pumps may be included pumps for booster service, as in tall buildings, and pumps for fire service. In both cases the load on the motor must be a secondary consideration, as it is essential under all circumstances to maintain a constant pressure. Even a rising pressure may be desirable where the friction is large. It is customary to select a pump with a flat or rising curve of sufficient capacity to supply the maximum demand, and to combine with it a prime mover that will not be overloaded at any point in the curve. This procedure may not produce a high efficiency, but the other requirements are so rigid that it can not be avoided.

Squire's All-Steel Steam Trap

Every indication at the present time points to the adoption of higher pressures and higher temperatures, particularly in the larger central stations. This has made necessary important changes in boilers, prime movers and many other types of auxiliary equipment. To meet these demands, a new all-steel steam trap has been brought out by the C. E. Squires Co., Cleveland, Ohio.

As will be seen from the illustration, the construction of the trap is somewhat unusual. The body is constructed of two heavy steel-plate flanges recessed on one side to receive a gasket and a short piece of extra-heavy pipe, the whole being bolted together with overall bolts. By increasing the thickness of the pipe and the flanges, the trap can be readily built for practically any desired pressure. It is also especially adapted to high superheat and the steel plate construction eliminates the trouble experienced with blow holes in steel castings.

The principle of operation is the same as used in the regular line of traps manufactured by this company and will be reviewed only briefly here. Referring to the illustration, the cast-iron bucket is hinged on

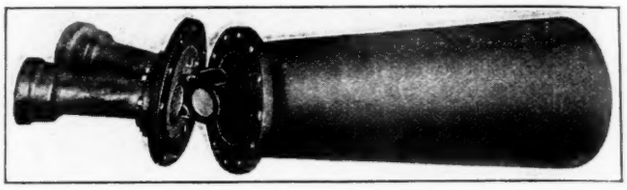


TRAP BODY CONSTRUCTED OF STEEL PLATE FLANGES AND HEAVY PIPE

tapered bronze bearings *B* and to it is connected the valve *C* by means of the stem *D*. When the condensation in the trap body reaches the high-water line, the bucket fills and sinks, opening the valve. The water is then discharged by the pressure in the trap, sufficient water remaining in the bucket to insure a water seal and prevent steam blowing through. When the water reaches the low-water line, the bucket rises, closing the valve, and the cycle is repeated.

Blowoff Protection for Empty Boilers

Where two or more boilers are connected to a common blowoff line, there is always the chance that the blowoff valves on a boiler that is down may be left open, giving an open path to the blowdown from another boiler on the line. As the action of emptying a boiler slows down toward the end, it is not unusual for an operator to leave his task with the intention of returning later to close the valves and upon occasion forget-



DOUBLE-SEATED FLAP VALVE TO PREVENT INWARD FLOW IN BLOWOFF LINE

ting to do so. From such an oversight workers have been entrapped in an empty boiler and fatally scalded, when the blowoff on another boiler has been opened by the boiler room attendant.

To prevent such a contingency, J. W. Pearl, 30 North La Salle Street, Chicago, has designed and copyrighted the double-seated flap valve shown in the illustration, with intention to apply for patents. The photograph shows the V-shaped flap valve hinged by a vertical pin between two 4-in. cast-iron pipes which receive the blowdown from adjacent boilers. The cone-shaped expander at the right was designed for a certain installation to discharge directly into a sewer manhole. It is 12 in. in diameter at the small end and 24 in. at the large end, giving an expansion ratio from one of the 4-in. pipes of 36 to 1 and therefore a safe velocity into the sewer, particularly as the diameter of the largest blowoff valve permissible under the A.S.M.E. code is 2½ in. Another type of fitting would be used to connect to a blowoff header or other connection to suit installation requirements.

It will be seen that the 4-in. pipes are brought into the flange carrying the valve, at an angle. This was done for convenience in laying and in order that the line of flow might cross the axis of the expander so that it would be filled completely with steam, but primarily so that the steam might impinge more directly on the opposing wing of the flap valve to swing it over and with the other wing close the mouth of the second blowoff pipe. The valve seated in this way blocks the entrance to the other boiler of the pair, the outcoming steam and any back pressure that might build up tending to hold it to its seat.

With the blowoff lines from each pair of boilers brought together in this way, the simple device under description would make up for any inadvertence of the operator and assure the safety of a worker in an empty boiler.

The potential energy contained in a high-pressure feed heater approaches that of the boiler itself. To generate steam at 500 lb. pressure, from condensate at 80 deg. F., with full regenerative feed heating, requires an expenditure of 400 B.t.u. in feed heating, and only 790 B.t.u. in evaporation. That is to say, over one-third of the heat transfer takes place outside the boiler. —*James G. Weir.*

EDITORIALS

F. R. LOW, EDITOR

Management in the Power Plant

THIS is "Management Week," so designated for observation throughout the country by a number of engineering societies and national civic bodies. By means of a comprehensive program of regional meetings to be addressed by outstanding leaders of industry, it is hoped to focus attention upon this important subject which is so closely linked with our social and economic welfare. Whatever material contribution this effort may make toward sustained prosperity will do much toward helping the problem of human industrial relations.

One usually associates management, as a science, with the production department and seldom thinks of it as applied to the power generating end of the works. This is probably because of the relatively small number of people employed in the latter as compared with the former, to the general freedom from labor troubles in the power plant, and to the fact that in most manufacturing plants the power cost is small compared with that of labor and material. Nevertheless, as power continues to increase in importance as a factor in production from the viewpoint of dollars and cents and continuity of service, the necessity for applying management principles is just as important as in the production department. Many of the larger industries now recognize this fact, and it would be well for others to take up the spirit of the week.

Eliminate the Smoke

ANNOUNCEMENT by the Bureau of Mines of renewed activity in the campaign for smoke abatement will be generally welcomed. War and post-war conditions with respect to fuel supply have been responsible for a spirit of tolerance and laxity in enforcing existing smoke ordinances, with the result that the public has witnessed a greatly increased pollution of the atmosphere in many sections that had previously been practically free from smoke. This is especially true of several cities along the Atlantic seaboard. The time has now arrived for placing a check on these conditions.

Large power stations employing mechanical stokers, as a rule, are not serious offenders, principally because they know how to burn fuel with little or no smoke and because they are convinced of the attendant saving. It is the hand-fired industrial plants, locomotives, steamships and industrial furnaces that are usually the worst offenders.

It has been frequently demonstrated that any fuel can be burned without objectionable smoke, and an educational campaign, instituted some ten or twelve years ago, was productive of gratifying results in many localities. But, as the Bureau of Mines pointed out, the problem is as much psychological as it is engineering, and it is absolutely necessary to arouse and sustain public interest through civic organizations and other bodies in order that continued enforcement may be secured.

There is abundance of information available in the Bureau of Mines and in the files of engineering literature that will show one how to burn coal without objectionable smoke. If your plant is in the offending class, do not wait for the community to act, but take the initiative and eliminate the conditions. If the cities are to get anywhere with the smoke problem, it will require the co-operation of every operating engineer as well as public interest in the enforcement of smoke ordinances.

A Definite Policy Needed

MOTIVE power in its various forms occupies a place of importance in modern civilization ranking with the food and water supply and in some ways ahead of these. It would be difficult to conceive of a greater calamity than a complete interruption of our power supply, if such a thing were possible. Industry, transportation and communication would cease, and in many cases our fuel, food and water supply would be cut off. In this country the use of electric power alone is increasing at a rate of approximately five billion kilowatt-hours a year, and our standards of living call for even a greater use of power if these standards are to endure. The shortage of common labor can be economically compensated for only by a greater use of power-driven machinery for doing the work that in the past has been performed by unskilled workers.

Notwithstanding the importance of an adequate and reliable power supply, the question of power development in certain groups of states has, during the last few years, been drifting toward a condition of uncertain policy. When the Federal Water Act was passed in 1920, it was thought that the way was cleared for extensive development of our water power. In so far as a federal policy is concerned, this has been true, as evidenced by the fact that since the creation of the Federal Water-Power Commission projects totaling two and one-half million horsepower have been completed or are under construction. However, some of the most important developments have again become deeply enmeshed in political controversy between states and the federal government and between national governments. The water powers of the Colorado, Columbia and St. Lawrence Rivers, involving some ten million horsepower, are examples of the stifling effects of these controversies. Certain states have inhibitions against exportation of power out of their boundaries, while others are inclined toward preventing power from being transmitted into the state. All these different policies react detrimentally to industrial expansion. Where such controversies exist, they must be settled before advantage can be taken of the economies possible with a proper co-ordination of steam stations and water-power developments and interconnection of power systems.

In a number of districts interconnection of power systems has been carried to such a state of development that the many advantages and economies of such arrangements have been thoroughly demonstrated. However, in the Middle Atlantic and New England States, the greatest industrial and power section of the country, little has been done toward interconnection of the different power systems, even though this district has been carefully surveyed and the many advantages of such interconnection established by exhaustive engineering studies. It is also in this district that the greatest divergency of policy exists between states regarding power developments.

It was for the purpose of starting a movement that would bring order out of chaos that Secretary of Commerce Herbert Hoover, with the approval of President Coolidge, called a meeting in New York City recently of the public-utility commissioners in these states, as reported in this issue. In the past the Secretary has in a number of instances demonstrated his genius for successfully working out such difficulties and getting the opposing parties to agree to some definite policy. This is what is badly needed in the Northeastern States regarding power development, and the Secretary is entitled to the whole-hearted support of each and every state interested to further the most economical development of its power resources and to promote industrial expansion.

Electrical Versus Mechanical Governing of Steam Turbines

SUPPOSE we were to scrap the direct-driven or oil-operated governing mechanisms and substitute electric motors for controlling steam turbines; many prospective purchasers would then be inclined to look for some other form of prime mover, with the usual reliable and easily maintained mechanical type of gear, perhaps to the detriment of the turbine industry. In many cases they would be justified. Electrical governing would be evidently so much out of place for a large number of familiar conditions as to nullify the virtues of uniformity and simplicity.

In spite of the natural tendency to incorporate mechanical governing methods in a mechanical prime mover, electrical auxiliary devices are at present practically indispensable in controlling turbines of medium and large capacities. In the pursuit of greater efficiency with its attendant operating complications, and requirements for more specialized governing, the electrical field presents practical developments and possibilities which should not be overlooked. It is also possible that, if electrical governing devices are developed and established, many of the present conditions, apparently justifying a mechanical type, would, on the contrary, present greater advantages for electrical control.

It is doubtless conceded that small units and auxiliary drive turbines are most satisfactory with mechanical gears. The direct-driven governor appears so naturally adapted to this service as to endure indefinitely. Mechanical governing devices which are comparatively compact and simple, depending for their action on not more than one or possibly two variable conditions, are preferable to electrical, generally speaking. There is an appreciable advantage in their being independent of an outside source of power. Where large distances, however, must be spanned by moving elements, or where a large number of variable factors control governing action, electrical control inherently possesses some advantage.

The speed adjustment of a main unit, controlled by means of a governor synchronizing spring, can be regulated by hand power as well as by an electric motor. The control-room operator, however, situated a considerable distance away, finds an electrical control superior to that by mechanical, including hydraulic or compressed-air means, as is apparent in general practice. This is for reasons of distance and convenience. There is no objection on the score of reliability. Similarly, where it is desirable to trip automatically the emergency valve when the circuit breaker opens, as sometimes is the case, an electrical device is the natural solution.

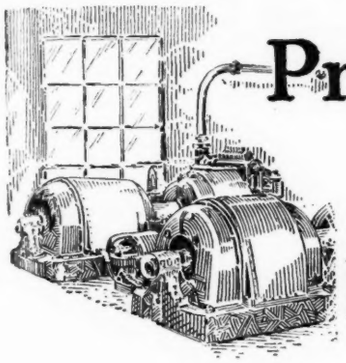
As a result of the demand for greater efficiency, comes the complications of steam extraction and reheating, as being reduced to practice. We encounter an increased number of mechanical automatic devices whose operation depends in some cases on several variable factors. Not only this, but there is a demand for more specialized governing, as in the case of the base-load unit, where flexibility of operation and other conditions are circumscribed more or less, with the object of producing highest possible efficiency.

Since in general constant load, independent of frequency, is desired, the centrifugal governor and hydraulic gear will in all probability be reinforced or replaced in some units, by an electrically controlled throttle valve, adjusted by the control-room operator.

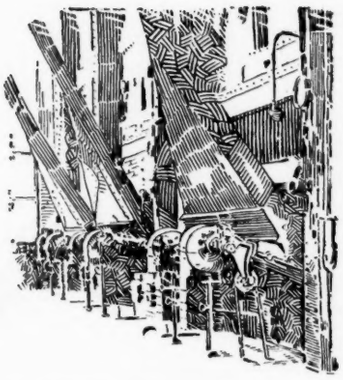
The question of failure in the power supply is automatically provided against in a prime mover. Its own inertia, applied through a generator, makes the power itself independent of outside sources of steam or electricity. We should not lose sight of the fact that electrical control is now developed to a high degree. Electrical functioning, as takes place in reversing steel mills, for instance, performs over and over complicated operations controlled by a multitude of variable factors. It is hardly conceivable that mechanical elements alone could approach the performance of magnetic contactors with an equal degree of satisfaction. While the electrical field is highly developed, possibilities of new applications as occasions may demand, are not lacking.

Another factor that must be considered is that the power plant is becoming of itself more subsidiary to the system as a whole. Efficiency and dependability of a system containing several plants may require that an old station should not be operated at its maximum economy. Therefore, a centralized plan of governing, now carried on largely by human agency, may give way to more nearly automatic means. Functioning according to established requirements, this may to some extent supersede human judgment and execution with more reliable results.

These pleasant, cool days in early fall, when the mind is clear and the body comfortable, are ideal days for inspection, repairs and the installation of new equipment. Now is the time to give the whole plant a thorough inspection and engineering housecleaning. Cover those bare pipes and fittings with adequate insulation. Inspect all traps and blowoff valves, stopping every leak of steam and hot water. Indicate the engine and reset the valves, if they need it. Test the condenser for leakage. Clean the boilers of scale and stop the air leaks in the setting.

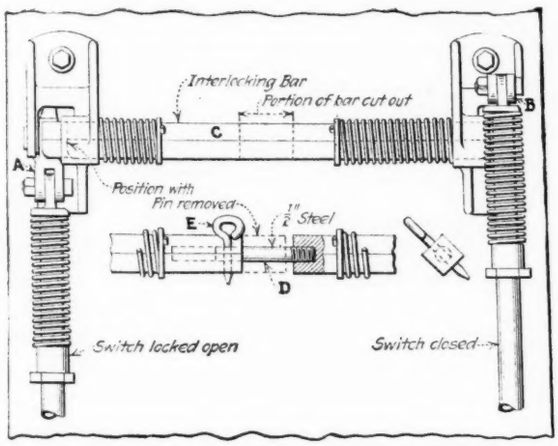


Practical Ideas *from* Practical Men



Eliminating the Interlocking Bar for Emergency Operation of Circuit Breakers

About two years ago the company with which I am connected installed a new switchboard equipped with two sets of busbars. Since that time we have experienced several interruptions due to the interlocking device on the circuit breakers preventing us from changing quickly from one busbar to the other.



WITHDRAWING PIN *E* REMOVES INTERLOCKING FEATURE

The main operating board is on the mezzanine floor, with the circuit breakers and busbar in the room directly below. The breakers are operated by hand from the operating floor by means of levers and connecting links.

The illustration shows the arrangement of the operating levers for the circuit breakers and the interlocking bar as installed on the back of the switchboard panels. The levers *A* and *B* are the switch levers that are operated from the front of the board. With the lever *A* in the position shown, the circuit breaker is open and the interlocking bar *C* is held over the lever *A* against the resistance of the spring by a projection on the lever *B*, which is in the closed position. In order to close the switch that is operated by the lever *A*, it is first necessary to trip out the lever *B*, then the interlocking bar *C* regains its neutral position, and the lever *A* may be operated and the switch closed.

From the foregoing it will be seen that in order to change from one busbar to the other with only one machine supplying current to the bus, it is necessary to interrupt the whole service, as one switch must be opened before the other is closed. To eliminate this trouble but still retain the interlocking for normal operation, a change was made as shown in the illustration. A portion of the bar *C* sufficient to allow it to clear both levers when in the closed position was cut out, and a piece of ½-in. round steel *D* was screwed into one end and made a sliding fit into the other. To hold the bar in its normal position and the same length as before, the ¼-in. pointed pin *E* was fitted in the bar as shown.

The change from one bus to the other can now be made without delay or the necessity of putting another machine on the line to save an interruption, as it is only necessary to withdraw the pin *E* and the bar springs free of the lever *A*, which can then be closed before *B* is opened.

R. A. DOUGLAS.

Des Moines, Iowa.

Getting Oil to a Bearing

Any shaft, if allowed to touch the metal of its bearing, would immediately heat and seize. The oil must interpose a film between the two metals, and since its frictional resistance is less than that of the metal, the amount of frictional heat is decreased, as is the power required to turn the shaft.

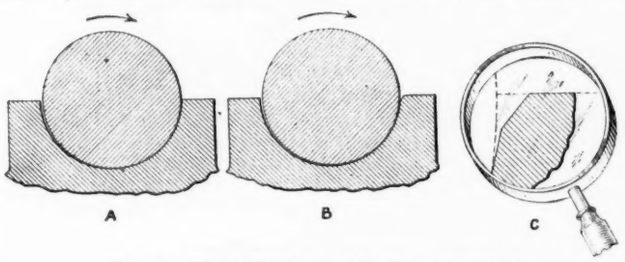


FIG. 1—CHAMFERING BEARING EDGES

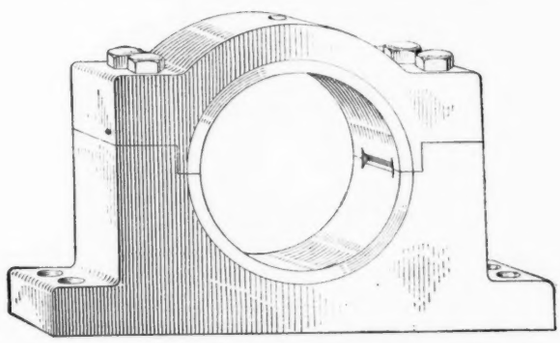


FIG. 2—BEARING WITH EDGE CHAMFERED

The difficulty with cup lubrication is to introduce the

oil between the revolving journal and the heavy surface upon which it rises. If the babbitt is brought up close, as shown in Fig. 1 at *A*, the oil film is broken or at least there is a tendency for the oil to be piled up at the edge. Each bearing should have the edge of the lower half chamfered as indicated at *B*. As shown enlarged at *C*, the chamfer should be made at two angles. The oil is then more or less dragged in between the shaft and bearing by the wedging action of the chamfer.

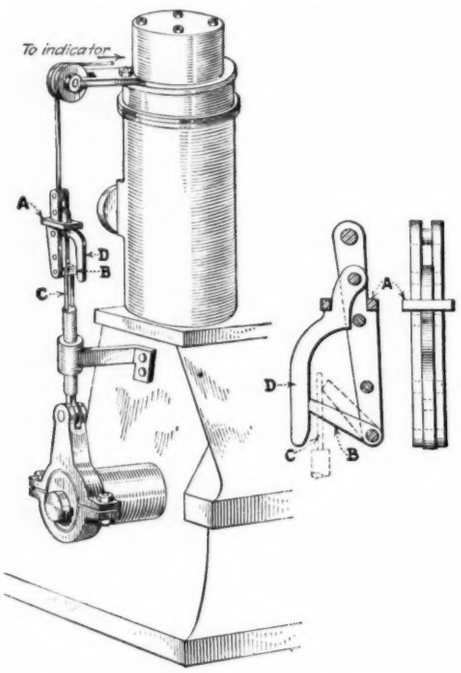
Fig. 2 shows the position of the chamfer in the bearing. As will be noticed, the bearing ends are not cut away; the idea of the solid portion is to prevent oil leakage at the bearing ends. G. GROW.

Philadelphia, Pa.

Indicator Hook for High Speed Engines

I have had a great deal of trouble finding a method of hooking and unhooking indicator cords when taking diagrams on oil engines of fairly high speed. After several attempts I found that the hook shown in the illustration was quite satisfactory.

In the illustration an eccentric fitted on the end of the shaft is employed as a reducing motion, but with



ASSEMBLY AND DETAIL OF HOOK

any type of reducing motion the only thing necessary is a loop of wire about $\frac{1}{16}$ in. in diameter shown at *C*. This loop should be about 1 in. longer than the stroke of the reduced motion, about 4 in. long for a small drum indicator with 3-in. stroke. The hook is about 3 in. long over all, with proportions as shown.

In order to hook the cord to the reducing motion, the hook is set up as shown in the detail with latch *B* in place and ring *A* holding trigger *D* in position to hold latch *B*. By holding the ring in place with fingers and pushing hook down in line of travel of loop *C*, shown by dotted line, the loop will come up and push latch *B* up, get above it and let the latch drop under the loop, thus hooking up the indicator. To unhook the cord, take hold of the hook above the ring with one hand and hold it in the lower position of travel. When the loop comes up, it will shake the ring loose, release the trigger and allow the latch to drop. If the ring sticks, it can be pulled up readily with the other hand.

With this hook it is easy to take diagrams on an engine running 400 r.p.m. However, it is well to wear gloves when using it on high-speed engines for a strong spring is needed to keep the cord tight and the hook will tear the hands if it slips out of them. The first pulley that the indicator cord passes over should be at least 12 in. above the highest point in the travel of the hook in order to give room enough for handling the hook. A. S. WALKER.

Buffalo, N. Y.

Pointers on Leaving a Job

Much is heard of the manner in which the engineer takes hold of a new job. It is almost a certainty that he will plan changes in equipment and methods with a view to improving operating conditions, and be enthusiastic to live up to the responsibilities entrusted to the position.

Not so much is heard of the way a man leaves his job, although it is vastly more important to the engineering fraternity in general and to the changing engineer in particular. When a new man enters the plant, mistakes are expected until he can learn the system and the routine, and allowances are usually made in a matter of this kind. So it is not so important after all as to how we grasp a new position. It is an easy matter for a competent man to demonstrate his ability to superiors.

There are numerous ways in which to leave a job. Very often the engineer or mechanic who voluntarily or otherwise leaves his position will not fail to grasp the opportunity to criticize the management or the plant, if for no other reason than that he feels at perfect liberty to do so, very often unjustly. What happens when this man leaves one position is likely to happen when he leaves the next place. The net result is that the man who cannot leave a place with the best wishes of his employer and fellow-workers finds it increasingly difficult to connect elsewhere. A man's reputation for fair dealing and the ability to get along with others has its due weight in the matter of responsible positions, and the man hard to get along with eventually finds himself looking for the job instead of the job for him.

On the other hand, consider the man who is looking to the future. It is just as much a part of his gospel to build good will among his various employers and fellow-workmen as it is for him to build his reputation as a first-class mechanic and engineer. When he leaves a position, he leaves with a feeling of good will on both sides. The habit of leaving a feeling of squareness and mutual good will behind is often the reason why some men of our acquaintance seem to prosper in an engineering way more than we do, although they may be no better artisans than ourselves. A mechanical genius may be able to do much as he pleases, but most of us are not wizards in any sense of the word and must be content to worry along building a reputation that will have some weight with the next man that we face sitting behind a mahogany desk.

Louisville, Ky. A. R. KNAPP.

Comments from Readers

Should Steam Be De-superheated for Use in Closed Heaters

I have read with much interest the article by Mr. Sprague in the Oct. 2 issue with reference to the advisability of de-superheating steam before using in closed-type feed-water heaters. Mr. Sprague, in his analysis of test results conducted on an evaporator, using in one case superheated steam and in the other case saturated steam, comes to the conclusion that superheated steam can be used to greater advantage. I offer the following analysis of the test results, which, I believe, on the contrary, show why it is advantageous to use only saturated steam in closed-type feed-water heaters where the degree of superheat is low; that is, under 100 deg. F.

The result of the test using saturated steam shows 188.5 lb. of steam evaporated per degree mean temperature difference. In the case of the test using superheated steam, however, Mr. Sprague has neglected altogether the influence of the high initial steam temperature due to superheat on the mean temperature difference, or temperature head. An analysis will show that in removing the heat of superheat and reducing the temperature from 599.3 deg. to 286.2 deg. (a temperature corresponding to the pressure in the coils) with the vapor pressure constant and the vapor temperature at 201.9 deg., the logarithmic mean temperature difference is 202 deg.

During the process of condensation the mean temperature difference is 84.4 deg. In other words, during the process of removing superheat we have a mean temperature difference of 202 deg., and during the process of condensation we have a mean temperature of 84.4 deg. Now, the total heat absorbed by the vapor equals the total water evaporated (17,800 lb.) times the latent heat of vaporization (976.6), corresponding to a temperature of 201.9 deg., or a total of 17,370,000 B.t.u. per hour. The heat given up by removing the superheat of one pound of steam under these particular conditions amounts to 153.6 B.t.u., whereas the heat given up by one pound of steam, under these conditions, condensing at this pressure, amounts to 919.6 B.t.u. The total amount of heat given up by one pound of steam is, therefore, 919.6 + 153.6, or 1,073 B.t.u. The percentage of heat due to condensing is, therefore, 85.5 and the percentage of heat due to the superheating 14.5. If we now refer these percentages to the total heat transfer in this particular case, neglecting radiation, we find that the total amount of heat due to condensing is 14,840,000 B.t.u. and 2,530,000 B.t.u. due to reducing superheat.

In order to arrive at an average mean temperature difference for the two processes, it is necessary to determine a weighted average based on transferring 14,840,000 B.t.u. with a temperature difference of 84.4 deg. and 2,530,000 B.t.u. with a temperature difference of 202 deg. This results in a mean difference for the two processes of 101.4 deg. F. The pounds of water evaporated per degree average mean temperature difference is, therefore, 17,800 lb. divided by 101.4, or 175 lb. which figure should be compared with the 188.5 lb. evaporated secured in the test using saturated steam, and not 211 lb. as shown by Mr. Sprague.

Mr. Sprague does not give us the total heating surface of the evaporator used for these tests. It is possible, however, to determine the transfer rate per degree temperature difference per hour for the total surface, which, inasmuch as the surface in both cases is the same, gives a true picture of the transfer rate due to de-superheating and due to condensing. If we divide the total heat due to condensing 14,800,000 B.t.u. by the mean temperature difference 84.4, we get a transfer rate of 176,200 B.t.u. per hour per degree mean temperature difference, and dividing 2,530,000 B.t.u., the heat due to reducing superheat, by the corresponding mean temperature difference of 202, the resultant rate is 12,520 B.t.u. per hour per degree mean temperature difference. The ratio of these two transfer rates is, therefore, 14 to 1. Or in other words, we are passing 14 times more heat per degree mean temperature difference condensing saturated steam than in removing the heat of superheat.

Looking at the matter from the viewpoint of transfer rate per square foot of surface, if we assume a case wherein the steam and water velocities are such that transfer rate due to condensing saturated steam is 500 B.t.u. per hour per square foot per degree mean temperature difference, the corresponding transfer rate for de-superheating would be 500 divided by 14, or approximately 35.5 B.t.u.

Inasmuch as closed feed-water heaters are designed on the basis of transfer rates per square foot, it may readily be seen from the foregoing that the de-superheating steam in equipment of this type would require a correspondingly large surface. While it is true that with high superheat as shown in Mr. Sprague's test, the surface required would be within reason because high temperature difference offsets the low transfer rate, with the modern bleeder type closed feed-water heater the amount of superheat barely exceeds 100 deg. F., which coupled with a low transfer rate, means excessive surface. This additional surface not only in itself increases initial cost, but greatly increases the mechanical difficulties of construction because of high water pressures now in use. The obvious solution of the problem is, therefore, undoubtedly an inexpensive and efficient de-superheater operated in conjunction with a closed-type feed-water heater.

The point may be raised that Mr. Sprague's tests show that more water was evaporated using superheated steam than saturated steam. In this connection I would again call attention to the fact that an extremely high degree of superheat existed in this test which will, of course, offset low transmission rates. Moreover, since Mr. Sprague does not give us the quantities of steam used in each case, there is the possibility that the evaporator used was probably "over-surfaced" for these particular test conditions.

F. B. SANDO.

East Orange, N. J.

Analyzing Coal with an Orsat

The article, "Recent Developments in Flue-Gas Analysis," by Mr. Lockwood in the Sept. 18 issue, puts the possibilities of using flue-gas analysis as a check on some of the properties of the fuel very clearly and thus brings it to the attention of many who probably never thought of it in this light before. The title, however, is somewhat misleading as such formulas are anything but recent or novel, as the writer worked in an engineering organization fifteen years ago where they were regularly used and knew of others doing the same.

Also the checking of the accuracy of Orsat work by means of an assumed fuel analysis is like using a rubber yardstick when a steel tape is available, as there is no better gas to test an Orsat on than air. Analyzing air will also show exactly where the trouble is in nine cases out of ten, whether leakage, aspiration of gas through imperfectly supported pipette filling tubes, temperature changes or incomplete absorption by solutions.

In order to be of value in instructing firemen in handling their fires, gas samples must be taken and analyzed quickly, getting CO_2 results in 3 or 4 minutes and complete analyses in 7 or 8 minutes; otherwise conditions have probably changed so much that it is all ancient history and the fireman's attention cannot be definitely called to the defects or advantages of the particular fire condition in question and its proof in the gas analysis. Under such conditions it is very convenient to have a rough check on the analyses which can be applied to them individually and instantly as they are completed, and it has been found and can be demonstrated by calculations from ultimate analyses, that the sum of the CO_2 and oxygen plus half the carbon monoxide will fall below 20.9 per cent by about one-sixth of the percentage of CO_2 found. Or, written as a formula,

$$\text{Per cent } CO_2 + \text{per cent } O_2 + \frac{\text{Per cent CO}}{2} = 20.9 - \frac{\text{Per cent } CO_2}{6}$$

This will hold for the ratios of available hydrogen to carbon found in particularly all coals mined east of Pittsburgh and can be applied by mental arithmetic almost as fast as the results of the analyses are written down. For ratio of available hydrogen to carbon found with oil and gasoline, the factor varies from 3 for heavier oils to 2 for lighter oils in which the hydrogen content is higher.

The natural limitations of Orsat analysis make it practically impossible to obtain results accurate enough to calculate the carbon hydrogen ratio of coals so that anthracite could be definitely distinguished from semi-bituminous or the latter from bituminous, but with the larger oxygen shrinkages resulting with oil and natural gas better results can be obtained. Such figures, while interesting, are of comparatively little value in figuring boiler tests or heat balances, as the flue-gas analysis cannot take into account the inert elements of the fuel such as moisture, whether it exists directly as water or combined as carbo-hydrates, nitrogen and ash. These inaccuracies of Orsat analysis, which should be recognized as the results of a compromise in producing a quick and easily worked apparatus for obtaining results entirely satisfactory for the purpose for which it was designed, arise from the volume of the manifold and pipette connections, varying absorption of gases by the water of the measuring pipette and still more so by the sampler if one is used, temperature changes during analysis and variations in time of draining of the burette walls before reading, not to speak of human errors of observation and recording.

Flue-gas analysis will always remain the final method of measuring the fireman's work, and with the flue-gas temperature of determining the flue-gas losses of boiler tests when the analysis of the coal is available (see Sommermeier "Coal" for method of obtaining ultimate analysis when the source of coal supply is known), but neither these formulas under discussion nor any others that may be developed, will give any real information bearing on boiler or internal-combustion engine efficiency without some assumption, direct or implied, as to the inert substances present in the fuel. On this basis I think the editorial, "Analyzing Coal with an Orsat," is misleading, as the calculation of the carbon hydrogen ratio from flue-gas analysis has been known and practiced for a long time, but has been given little prominence, as everyone who has used it in practical work has realized its doubtful accuracy and limited usefulness in obtaining definite figures on the performance of the apparatus under test.

H. D. FISHER.

New Haven, Conn.

Locating Brushes on the Neutral of Interpole Machines

I read with much interest the article by B. A. Briggs in the Sept. 4 issue entitled, "Locating Brushes on the Neutral of Interpole Machines," and it occurred to me that the methods I have frequently used in locating the neutral of an interpole motor might be of interest to other readers. While the method is only approximate, it may be found convenient when time and suitable equipment are not available for a more elaborate check.

First Method—After ascertaining that the brushes are uniformly spaced around the commutator and that they are parallel to the commutator segments, as outlined by Mr. Briggs, open the shunt-field circuit and cut out the series-field winding if the motor is compound-wound, by changing the line wire to the connection between the interpole and series-field windings. Fig. 1 shows a diagram of the connections as normally made, and Fig. 2 shows the connections with the shunt-field circuit open at the starting box and the line connection changed to cut the series winding out of circuit, ready to test if the brushes are on the neutral. On a shunt interpole motor the only thing to be done is to open the shunt-field circuit at the starter, as in Fig. 2. Then disconnect the motor from the load, close the switch and

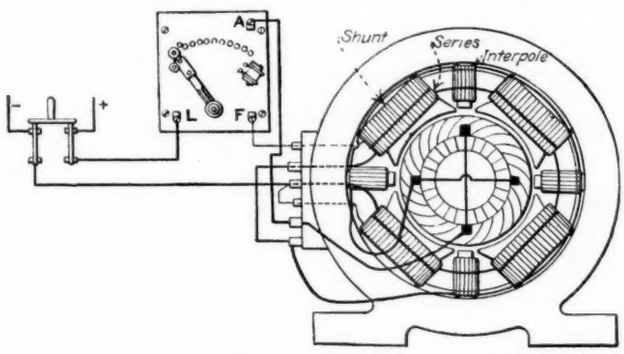


FIG. 1—DIAGRAM OF CONNECTIONS AS NORMALLY MADE

place the arm of the starting rheostat on the first button. If the brushes are on the neutral, the torque produced by the current flowing through the armature and interpole windings will be zero, and the motor will have no tendency to rotate in either direction, even though given a start. If, however, the brushes are off neutral, there will be a torque produced proportional to the sine of electrical degrees the brushes are off neutral and the motor will have a pronounced tendency to rotate either in one or the other direction, depending upon which

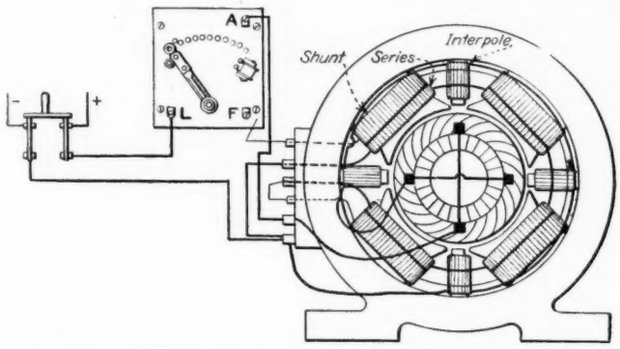


FIG. 2—DIAGRAM OF CONNECTIONS WITH MOTOR READY FOR TEST

way the brushes are off neutral. The brushes are then moved in the direction opposite to that the motor has a tendency to rotate in until this tendency ceases, indicating that the torque produced by the armature and interpole fluxes is zero, consequently the brushes are on the neutral.

Second Method—Run the motor idle first in one direction and then in the reverse direction, and adjust the brushes until speed in either direction is about the same.

Both methods give the no-load neutral, which should be the same at all loads if the interpoles are properly designed, as pointed out in Mr. Brigg's article. If, however, poor commutation is observed at different loads, the interpole field has to be modified as outlined in the article referred to. If such modification is too troublesome and if the load is fairly constant, the brushes may be moved to a point of best commutation, which is the position of the neutral at that load, and let go at that.

Carteret, N. J. E. OGUR, Test Engineer,
U. S. Metals Refinery Co.

Does a Partly Closed Feed Valve Increase the Duty on the Feed Pump?

Replying to the inquiry of Mr. Harris in the Sept. 18 issue, "Does a Partly Closed Feed Valve Increase the Duty on the Feed Pump," I would say that it does and the amount that the duty is increased depends on the increase in the pressure. The pressure at the feed pump must necessarily be higher than the boiler pressure, even if the feed valves are wide open, in order to overcome the friction in the feed line. If the feed valves are closed sufficiently to raise the pressure, say, 25 lb. above what is necessary to feed the boilers with the valves wide open, and the pump is delivering, say, 1,000 lb. of water per minute, the extra work done by the pump would equal $1{,}000 \times 25 \times 2.3 = 57{,}500$ ft.-lb. (2.3 being the height in feet of a column of water equal to 1 lb. pressure per square inch).

In our plant we have a pump governor of the constant-pressure type, the result being that the boilers get more water when the steam pressure is low than when it is high. We find it necessary to carry the discharge pressure at the pump at least 15 lb. higher than the maximum boiler pressure. My preference would be a constant differential (or head) type of governor. As to smoothness of running there should be no difference.

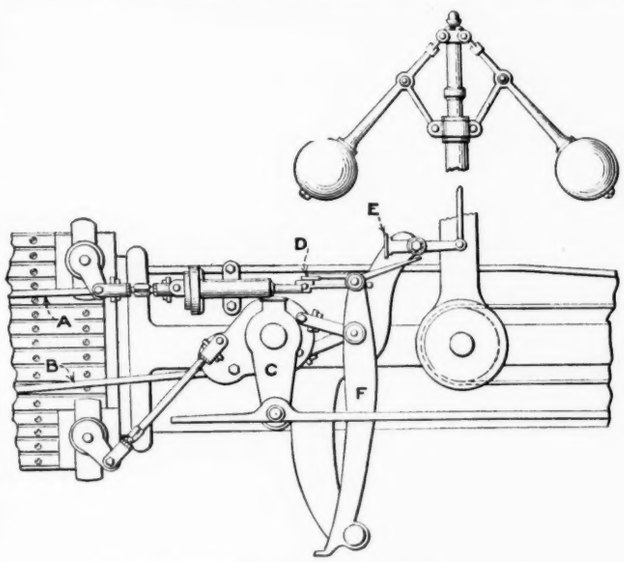
I once had charge of a battery of boilers and my practice was to set the feed valves as wide open as possible (some having to be closed partly in order to divert water to others) and regulate the speed of the pump to suit the requirement for water. As it was a street-railway plant, there was the inevitable peak load to consider. Occasionally, I was able to set the pump early in the afternoon so that no further adjustment would be necessary until the peak load was over. This meant that the pump was running a little too fast for the off-peak period and a little too slow for the peak-load period and that when the peak came on there would be a good supply of water in the boilers.

Toronto, Ont., Canada. R. MCLAREN.

Early Corliss Valve Motion

I read with interest the article by M. V. White in the Aug. 28 issue, describing the old side spring-lever valve motion as used on the early types of Corliss engines. Part of my early experience was operating two engines fitted with this type of valve gear at the American Sheet Iron Works at Phillipsburg, N. J. One of them, 24x48 in., was built by Miller & Allen, Chester, Pa., about 1868; the other, 22x48 in., was built by George H. Corliss about 1870.

In the illustration of the valve gear shown herewith, *A* is the reach rod to the head-end inlet valve and *B*

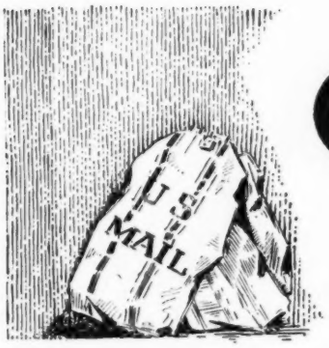


VALVE GEAR USED ON CORLISS ENGINES FIFTY YEARS AGO

the reach rod to the head-end exhaust valve. The wristplate *C* is shown with the eccentric rod hooked up. *D* is the latch block and *E* the knock-off cam. Two leaf springs were suspended in the frame *F*, and these closed the valves at cutoff, instead of a dashpot as was later adopted on the Corliss type of engine.

The illustration here shown was taken from Bourne's Catechism of the Steam Engine, published in England about 1865. W. K. HOWELL.

Iola, Kan.



QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Blowdown for Twin Safety Valves

What should be the blowdown for two 3-in. pop safety valves or twin valves on a boiler carrying 125 lb. gage pressure? A. B. L.

Safety valves should close after blowing down not more than 6 lb. on boilers carrying between 100 and 200 lb. gage, and a safety valve set for 125 lb. should be adjusted so that amount of blowdown will not be exceeded. Regrinding would have no appreciable effect in changing the amount of blowdown below the pop pressure.

Number of Boilers To Use for Different Loads

A boiler plant consists of three boilers each having a grate 6 ft. wide and 5 ft. 6 in. long. The fuel is soft coal, hand fired. The day shift burns 9,200 lb. in 8 hours, and the night shift burns 5,100 lb. in 8 hours. For good economy how many boilers should be used for each shift? A. B.

With the day shift the coal consumption is 9,200 ÷ 8 = 1,150 lb. per hour, and with the night shift it is 5,100 ÷ 8 = 637.5 lb. per hour. With good natural draft the combustion rate should range between 20 and 30 lb. of coal per sq.ft. of grate per hour, requiring the use of 57.5 to 38.3 per sq.ft. of grate with the day shift and about 32 to 22 sq.ft. of grate with the night shifts. As each boiler grate has an area of 6 ft. × 5 ft. 6 in. = 33 sq.ft., with good firing best results should be obtained from the use of two boilers for the day shift and one boiler for the night shift.

Placing Strainers in Pump Suction

In the plant where I am employed, the discharge of the circulating pump is provided with a twin strainer, and although the suction is equipped with a strainer, the water carries abrasive material that wears the pump. The engineer in charge is considering the advisability of placing the twin strainer in the suction pipe close to the pump. Is there any objection to that arrangement? A. C. T.

The only objection to placing strainers on the suction side of the pump is the reduction of suction head of the pump. With the strainers placed on the discharge side as at present, the loss of pressure sustained from passing the water through them can be compensated by the pump exerting the necessary additional discharge pressure, but from placing the strainers on the suction side, when pumping at the same rate, the suction pressure of water supplied to the pump will be reduced as much as the delivery pressure must now be increased from use of strainers on the delivery side. Hence, whatever this pressure may be, it would cause the same reduction of pressure on the suction supply to the pump reckoned in pounds per square inch, if above the pressure of the atmosphere; and for any excess of this pressure, or if the pump is at present operating with a suction lift, each pound per square inch of pressure lost would be equivalent to increasing the suction lift 2.3 feet.

Placing Thermometers in Ammonia Lines of Refrigerating Plant

Where should a thermometer be placed in the liquid line of an ammonia refrigeration plant to observe the temperature of the ammonia, and what should be the temperature with back pressures of 15 to 46 lb. gage? H. G.

Many receivers are provided with a plugged hole for removal of the plug and insertion of a steel thermometer well for receiving a thermometer after the well has been filled with oil. If there is no such condition, a tee for a thermometer well may be placed in the liquid line from the receiver to the expansion valve. However, the most desirable place for a thermometer is in the suction line, close to the compressor, for determining the temperature of the suction gas coming from the ammonia coils. Then by checking up the temperatures with a table of properties of ammonia, such as given in Power's "Refrigerating Pointers," it may be determined whether there is much superheating of the gas or if it is coming over slightly moist. For example, with a temperature of 15 lb. gage the temperature of the ammonia vapor should be 0 deg. F. A temperature of 40 deg. F. would show that the ammonia has picked up considerable heat in coming from the evaporating coils requiring unnecessary work of the compressor to compress this highly heated vapor, besides reducing the output, since the volume of the gas is increased and the compressor can handle only a certain number of cubic feet of vapor. The condition should be such that the temperature will be at saturation. Then the suction line will be frosted over up to the cage valve, without frosting the valve cage or cylinder jacket.

The gage pressures nearest within one-half pound, corresponding with different temperatures, 5 to 35 deg. F. of saturated ammonia are as follows:

Temp., Deg. F	Gage Pres., Lb. per Sq.In.	Temp., Deg. F	Gage Pres., Lb. per Sq.In.	Temp., Deg. F	Gage Pres., Lb. per Sq.In.	Temp., Deg. F	Gage Pres., Lb. per Sq.In.
—5	12	5	19.5	15	28.5	25	39
—4	13	6	20.5	16	29.5	26	40
—3	15.5	7	21	17	30.5	27	41.5
—2	14	8	22	18	31.5	28	42
—1	15	9	23	19	32.5	29	44
0	16	10	24	20	33.5	30	45
1	16.5	11	25	21	34.5	31	46.5
2	17	12	25.5	22	35.5	32	47.5
3	18	13	26.5	23	37	33	49
4	19	14	27.5	24	38	34	50

Crib for Centrifugal Pump and Motor

We have a crib 8 ft. by 12 ft. by 7 ft. deep for holding a 12-in. centrifugal pump and 75-hp. motor. The bottom of the crib is made of 2 x 8-in. joists and the sides are cribbed with 2 x 4-in. with 2-in. calked planking on the inside. The crib is anchored to four large piles. During freshets the water is likely to rise within 12 in. of the top of the crib. What will be the buoyancy of the crib?

T. W. H.

When the crib is immersed in water, the lifting force of the water is equal to the weight of water displaced, and the buoyancy of the crib, or tendency to rise, will be the weight of water displaced minus the resistance of the anchorages and gross weight in air of the crib and load supported by it. When the crib is surrounded by water within 12 in. of the top, the volume of water displaced would be $8 \times 12 \times 6 = 576$ cu.ft. Calling the weight of one cubic foot of water 62½ lb., the lifting force of the water would be $576 \times 62\frac{1}{2} = 35{,}904$ lb., or about 18 tons of 2,000 lb. each.

A crib of the construction described should have the sides braced by struts between the opposite sides, and, unless the force required to pull up the piles is known, their resistance as anchorages should not be depended upon. If the gross weight of the crib, housing and machinery is not about 20 tons, the difference should be made up by a dead weight of stones, concrete or other material.

Use of Preheated Air Supply for Small Boiler

We burn about 3½ tons of coal per week and have a dry room tumbler that discharges 5,000 cu.ft. of air per minute at a temperature of 230 deg. F. What saving would be effected if this air is supplied to the boiler furnace, instead of using natural draft with the room temperature about 95 deg. F., and what effect would it have on the grates?

G. W. H.

The benefit from supplying heated air would be derived from obtaining somewhat more perfect combustion of the fuel and a gain of heat represented by the greater amount of heat contained by the air supply. Assuming that the coal as fired contains 14,000 B.t.u. per pound and the combined efficiency of furnace and boiler is 50 per cent, then from each pound of coal there is realization of 7,000 B.t.u. The air supply used per pound of coal probably is about 200 cu.ft., and the specific heat of air is about 1 B.t.u. per degree F. change of temperature of 50 cu.ft. of air. For 200 cu.ft. of air supplied at 230 deg. F., in place of 95 deg. F. the gain would be $(230 - 95) \times 200 \div 50 = 540$ B.t.u. per pound of coal, and upon the foregoing assumptions would amount to $\frac{540 \times 100}{7{,}000} = 7\frac{7}{10}$ per cent. With an ashpit of ordinary depth, kept clean of ashes, the higher temperature of the air supply should have no serious effect on the grates.

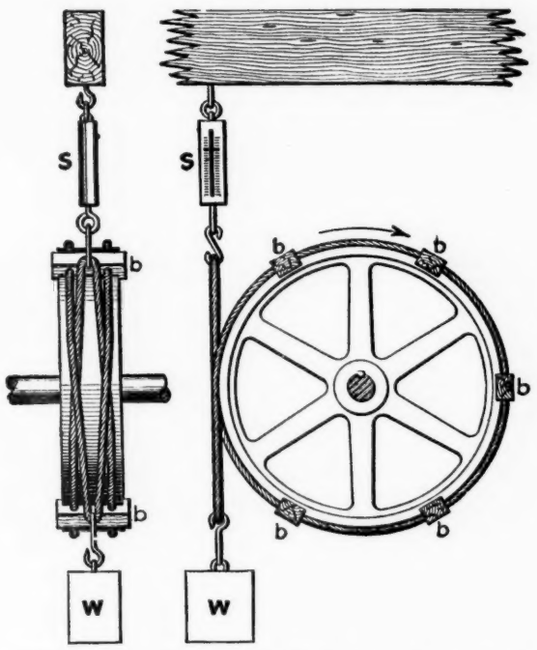
Rope Brake for Testing Brake Horsepower Developed by Motor

How can measurement be made with a rope brake of the power developed by a motor running 850 r.p.m. using a direct-connected 12-in. diameter by 4-in. face brake pulley?

R. D.

The arrangement of a rope brake is shown in the illustration. Having rotation in direction indicated by the arrow, a rope made up endless is passed around the pulley and kept from slipping sideways by notched wooden cleats *bb*, with projecting ends to prevent the cleats from moving across the pulley face and notches for holding the rope in place. A spring balance *S* supports one fold of the rope, and a weight *W* is suspended from the other fold. Then the resistance to rotation will be the weight *W* minus the indication on the scales, with a lever arm equal to the radius of the pulley plus one-half the diameter of the rope.

When *R* is the length of the lever arm in feet, *W* the



ROPE BRAKE FOR TESTING POWER DEVELOPED BY MOTOR

net weight or brake load in pounds, and *N* the number of revolutions of brake wheel per min.,

$$Brake\text{-}horsepower = \frac{2 \times 3.1416 \times R \times W \times N}{33{,}000} = 0.0001904$$

When *R* is given in inches,

$$Brake\text{-}horsepower = 0.00001586 \times R \times W \times N$$

Hence for a pulley 20 in. in diameter, or 10-in. radius, and rope ½-in. in diameter, *R* in the formula becomes 10.5; *w* = dead weight *W* lb. — *S* lb. indicated by the spring balance, and with *N* = 850 r.p.m.,

$$Brake\text{-}horsepower = 0.00001586 \times 105 \times (W - S) \times 850 = 0.1415 \times (W - S)$$

For example, if with the motor running 850 r.p.m., a dead weight *W* = 70 lb., is sustained, and there is a pull on the spring balance *S* = 12 lb., then

$$Brake\text{-}horsepower = 0.1415 \times (70 - 12) = 8.2\ b.hp.$$

To prevent the rope from burning, it should be kept moistened with water, and the separate values obtained for *W* and *S* will depend on friction between the rope and face of the pulley.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Easy Lessons in Engineering

Economical Boiler Operation

Aside from keeping power on the line at all times, a matter which every engineer attends to as a matter of course, the all-important thing in any power plant is to keep the cost of power as low as possible. The capital charges and the possible efficiency are practically determined when the original equipment is purchased. The equipment installed, it is up to the engineer to produce the cheapest power possible with the means at hand.

The first thing to consider is the possibility of saving money by changing to a cheaper or more expensive grade of fuel. When the installation is completed and the kind of fuel decided upon, the over-all boiler efficiency becomes an approximate measure of the commercial economy with which the station is operated. In certain cases, however, allowance must be made for more rapid depreciation of furnace refractories with high efficiency. This is due to the fact that high furnace temperatures generally accompany high efficiency.

Outside of the boiler room the operating engineer can do little to improve the efficiency of the plant beyond seeing that the apparatus is in proper adjustment. So, from the operating viewpoint, practically the only chance for a big saving lies in boiler operation. Fortunately, the opportunity there is a large one, worthy of any engineer's talent. Consider that the average boiler operates at 50 per cent efficiency and that this could easily be raised to 65 per cent by a knowledge of combustion plus an insignificant expenditure for instruments. This increase in efficiency would save $15 \div 65 = 23$ per cent of the original coal bill (including coal and ash handling).

What steps are necessary to obtain this saving? The first and most important is to reduce the percentage of excess air to the minimum obtainable with complete combustion. The easiest way to determine excess air is to analyze the flue gases for CO_2, although high furnace temperature may be taken as a rough indication of high CO_2 and low excess air.

The first place to take an Orsat sample is at the breeching connection. Suppose the CO_2 is 6 per cent there. This shows at once that there is a big unnecessary flue loss, as the percentage should run from 12 to 14. The trouble may be in the upper part of the setting or in the furnace, probably in both. To tests the first possibility, sample the gases in the first pass, taking a simultaneous sample at the breeching. Suppose the first pass shows 10 per cent of CO_2 when the breeching shows 6 per cent. This indicates a serious air leak between these two points. The next step is to go over the whole setting with a candle, plugging all the leaks thus discovered. Additional tightness may be obtained by coating the setting with an airtight mixture.

This done, repeat the analysis, getting, say, 11 per cent in the first pass and 10½ per cent at the breeching. The increase in the first pass indicates that some leaks have been stopped below that point, while the small remaining difference of ½ per cent between first pass and breeching shows that section of the setting to be practically free from leaks.

While 10½ per cent CO_2 is not bad as plants go, it should be possible to obtain at least 12 per cent. Further improvement must come from studying the fire. With natural draft, make sure that the ashpit doors are wide open at all times or, better, removed altogether. The draft should be controlled entirely by the uptake damper. Any attempt to throttle the air inlet below the fire will increase the suction above the fire with a corresponding increase in air leaks through the setting and firedoors. Firedoors should be open no longer than necessary.

Where forced draft is used, it should be regulated to suit the load while the chimney damper should be adjusted to keep a slight suction only, or a zero draft, over the fire. This will greatly reduce air leakage.

Next study the fire itself. Is it uneven in thickness or color? Are there dead spots or holes where useless air rushes through? Is the cleaning done in such a manner that much air gets up through dead sections of the grate? Is the firing done in large quantities at long intervals? Is the fire too thin for proper handling? If stokers are used, is air rushing up through the back portion? If any of these conditions exist, they should be remedied.

In this connection it should be mentioned that it is often necessary to introduce air over the fire to burn the gases, but that this air should be strictly under control and admitted in such a way that it will immediately be well mixed with the gases.

This brings up the question of incomplete combustion, as indicated by CO in the flue gas. Good combustion consists in obtaining complete combustion with only a small amount of excess air. To accomplish this, all the air supplied must be thoroughly mixed with the gases at the earliest possible moment and in a space where the temperature is high enough to cause immediate ignition. Mixing arches and expanses of hot brickwork are useful in this connection. Moreover, the size and design of the combustion space must be such that the flame is burned out before the gases reach any water-cooled surfaces. Otherwise combustion will be incomplete. With good settings and good operation it should be possible to obtain from 12 to 14 per cent CO_2 with practically no CO. The CO should be checked from time to time with an Orsat.

If the flue temperature is high with good CO_2, the trouble lies in poor heat absorption rather than poor combustion. In such a case the tubes should be cleaned inside and out and the baffles inspected for leakage.

If these things are done and reasonable attention is paid to loss of combustible in the ashpit and losses of steam and hot water, good economy is sure to result.

Free Flow of Power Between States

Secretary Hoover and the Public Utilities Commissioners of New England and Middle Atlantic States Set Machinery in Motion To Improve the Power Facilities in These Districts

WITH the approval of President Coolidge and on invitation of Secretary of Commerce Hoover, the Public Utility Commissioners of the New England and Middle Atlantic States met with the Secretary in the Engineering Societies Building, New York City, Oct. 13, and had a preliminary discussion of the steps that could properly be taken by federal and state authorities in the promotion of superpower development in the Northeastern States. The meeting was opened by an address from Secretary Hoover, which is given herewith. Mr. Hoover stressed the fact that the meeting had nothing to do with any political controversies now going on in New York State over water-power development or what should be done with the Adirondacks. Public Utility Commissioners of the ten Northeastern States attended the meeting and unanimously indorsed in principle the superpower program for co-ordinating the power facilities of these states. All the commissioners expressed themselves as being willing to co-operate to bring about a free flow of power between their respective states. It was agreed that the engineering problems had been solved, but that the difficulties remaining to be contended with were the elimination of laws inhibiting the transmission of power from one state to another and establishing equitable rates between the different companies for the power that may be transmitted from one system to another.

It was the opinion that the two latter problems should not be difficult since such problems had already been worked out satisfactorily in certain sections of this district. Sentiment expressed by the commissioners was to the effect that federal regulation of power between states was not desirable. Among the suggestions made was a uniform statute that the governors could present to their state legislators for adoption. This might be fashioned after the uniform securities act. A treaty between states might be entered into such as already has been done between a number of the western states on water-power development, or the agreement between New York and New Jersey establishing the Port Authority.

At the suggestion of Mr. Hoover it was agreed to hold another meeting within a month or six weeks, at which chambers of commerce members, industrial boards, public-service corporations and banking officials and members of state bodies interested in this problem would be invited. The Secretary suggested that he draft a tentative program to be submitted to the various commissioners for suggestions and approval.

Those who took part in the discussion were: W. S. Murray and E. S. Buckland, of the Federal Superpower Commission of 1919; W. A. Prendergast, chairman, New York State Public Service Commission; W. T. Gunnison, chairman, New Hampshire Public Service Commission; R. T. Higgins, chairman, Connecticut Public Utilities Commission; W. C. Bliss, chairman, Rhode Island Public Utilities Commission; E. E. Stone, Massachusetts Department of Public Utilities; D. B. Ainey, chairman, Pennsylvania Public Service Commission; W. A. Dutton, chairman, Vermont Public Service Commission; H. V. Osborne, chairman, New Jersey Public Service Commission; C. E. Gurney, president, Maine Public Utilities Commission; H. Carl Wolf, chief engineer, Maryland Public Service Commission; M. H. Aylesworth, manager, National Electric Light Association; O. C. Merrill, executive secretary, Federal Water Power Commission.

Secretary Hoover's Address

I have called this conference with the approval of the President for a preliminary discussion of what co-operative steps federal and state authorities can properly take in the promotion of what is called the superpower development in the New England and Middle Atlantic States. This conference is not conceived as more "government in business." The public authorities are already deeply in the power business through many forms of regulation and a very large measure of control of power sources. The thought here is that co-ordination among public authorities and industries may secure further consummation of a great advance in the development of a great service to the public.

The reason and need for this discussion is simply that engineering science has brought us to the threshold of a new era in the development of electric power. This era promises great reductions in power cost and wide expansion of its use. Fundamentally, this new stage in progress is due to the perfection of high-voltage longer-distance transmission and more perfect mechanical development in generation of power. We can now undertake the cheaper sources of power from water sources further afield, such as the St. Lawrence and cheaper generation from coal through larger and more favorably placed generation plants. We can secure great economies in distribution through the interconnection of load between systems and thus secure a reduction of the amount of reserve equipment, a better average load factor through pooling the effect of day and seasonal variations, together with wider diversification of use by increased industrial consumption. We can assure more security in the power supply from the effect of coal strikes and from transportation interruptions.

All this means the liquidity of power over whole groups of states. Once power distribution spreads across state lines diverse legal jurisdictions are encountered. We are, therefore, confronted not only with problems of the co-ordination in the industries of their engineering, financial and ownership problems, but also with new legal problems in state rights and federal relations to power distribution.

This super-development of great areas of cheaper power has been dramatized by those less familiar with the problem as the construction of great power highways traversing several states into which we should pour great streams at high voltages from great giant water-power or central steam stations to be distributed to the public utilities and other large users along the lines of these great power streams. This, indeed, serves perhaps to picture what is meant by superpower development. As a matter of practical fact, however, the natural development of this situation lies first in the interconnection of power supplies between the existing great utility systems, and second, in common action for the erection of large units of production at advantageous points for the mutual supply of two or more of the present systems and in the development of such great water powers as the St. Lawrence.

Three years ago, at the instigation of our engineering societies, the federal government undertook an exhaustive study into the possibilities of more comprehensive and co-ordinated development in the Northeastern states. This survey, under Mr. Murray's able direction, in which I also participated in an advisory capacity, demonstrated that the savings in these eleven states of a co-ordinated and fully developed electrical power system by the time it could be erected could amount to a conservation of about 50,000,000 tons of coal per annum; that an annual saving could be made of over $500,000,000 per annum at an additional capital outlay of about $1,250,000,000. In this area we are today producing something like 9,000,000 hp. by direct steam and individual plant generation, a substantial part of which could be transferred to central generation with great economy.

With the crowding of our population in large areas we are faced with most difficult questions in the development of terminal facilities, the handling of traffic on our railways. There has been some electrification of transportation. The engineers who have made systematic superpower surveys are convinced that over 40 per cent of the mileage of the railways in this territory could be electrified at substantial economies in operation and with enlarged service if we should secure this greater and more economical power development.

The indirect results both human and material are even more important than these figures I have given would imply. They do not take account of vast losses to industry and commerce by the actual interruption and threatened interruption of fuel supplies to our several hundred thousand independent power units; no account of the relief to shippers from our already overburdened transportation and terminal

facilities; no account of the increased production of our factories from cheaper power; no account of the larger extension of power into farm and home; in the reduction of physical labor, and increase of comfort.

This new era of advanced projects is no theorists' or promoters' dream. It is a basic fact unanimously supported by our engineers; agreed to by the responsible men in the industry. It is true that there has been progress in the actual application of scientific advances in our national equipment, but we are far from the realization that is today practicable. I do not wish to be construed as stating that no progress has been made in enlarged co-ordination of power production and distribution. The electrical companies, under the regulation of the public service commissions, have already made excellent progress in the application of superpower principles in many localities. Power interconnections on the Pacific Coast reach from the southern border of California to Oregon; the States of Illinois, Indiana, Wisconsin and Michigan are associated in a network of interconnections, as are Georgia, Alabama, North and South Carolina and Tennessee. This being the case—one purpose of this conference is to consider—why does this development in this, the greatest power zone of our country, where the greatest saving can be made, not make progress? What measures can be devised to stimulate it? What obstacles in its realization can be removed?

I do not wish to anticipate the results of the conference, but I may point out that the state and national governments are blamed by some persons for this lack of progress. It is said that there is a lack of definite principles and of co-ordination in the policies of necessary regulation of power utilities by the different states and a lack of co-ordination and vision in our national administration of the development of nationally controlled power sources. It is also said that we should not permit the rivalry between our distribution systems and competition for territory to restrict the establishment of interconnection of load and the development of great generation units for their common use.

Whatever the fault may be, it is the purpose of this conference to give preliminary consideration to the problems and principles that might be adopted in interstate relations; to discuss what measures can be devised to assure this needed development and what obstacles in its realization can be removed.

In the matter of public relations to power development and distribution it appears to me that one of the first principles we must realize is that the whole of this development implies the free flow of power. We have thus at once created at least a physical and economic interstate question. This great development of so much public interest cannot come about unless there is a complete liquidity in movement of power back and forth across the boundaries throughout the whole of the United States. We cannot secure centralized generation, great water-power development, or interconnection of load unless there is this free flow. Without this we shall have permanently a larger cost of power and less expansion in its service. There are time-honored disputes, over states rights with regard to water, and somewhat similar questions are being raised as to power. Subject always to the sovereignty of states in taxation, etc., unless all citizens irrespective of state may have the same rights as to use of power, we will destroy the hopes of a very great economic development.

I am advised that it is probably true that no embargo could be constitutionally placed upon power flow across state frontiers, but unco-ordinated legislative and regulative actions by the states and national government might amount to economic embargoes and discriminations and thus stifle development.

Again my argument that we must have free interstate flow of power implies free flow within the states and applies with the same strength to the complete necessity of state-wide regulation uninterfered with municipal obstruction. Otherwise we shall have the same dams erected and, thereby, an increase of costs and the destruction of the ultimate public advantages to be obtained in this necessity of life and growth.

The regulation of power distribution, profits or rates is a concept fully fixed into our governmental system.

The economical distribution of power rests to a large degree upon local territorial monopoly. Competitive overlap of power-distribution systems would represent tremendous capital and distribution waste. When we accept the principle of monopoly, we at once must accept the principle of public regulation. This is a fundamental conception upon which there is no need for dispute or argument. It is amply accepted by universal state legislation. Our states have wisely created public-service commissions with state-wide regulatory power in order that rates, profits and distribution might be controlled.

I am not here to advocate federal regulation of interstate movement of power. I believe that power development and distribution would find its greatest solution in co-ordinated state regulation, perhaps with assistance and co-operation of the federal government, rather than in any superstructure of authority such as has been found necessary in transportation unless, of course, necessities of the case cannot be attained otherwise.

In national relations to power development the public reaction against waste and exploitation of our national resources some years ago brought about a great movement for conservation, but it imported into the practice of conservation an implication of cold storage for these resources. We must adopt a new thought on conservation. Real conservation lies in use for public interest, not in prevention of use. Every water horsepower that can be used today which runs to waste is a burden on man power, nor am I here to advocate that the federal government abandon its policies to conservation of national resources; but I do advocate their proper use for the nation, not the deprival of the public through old fetishes, old hates and inertia.

One phase of public relationship in this district is involved in the great water-power development of the St. Lawrence. It is of vital importance as an enormous contribution to the whole northeastern states. The American share would amount to 1,200,000 hp. producible at a cost far lower than any form of fuel generation. It is a pitiable waste today and can only be mobilized by co-operation of the federal government.

In any event the problems we are here to discuss are from a public point of view that by virtue of these scientific developments power has now become an interstate question. If, in our interstate conflicts, or national policies, we are hindering the development of progress of so fundamental a thing, it is but right that we should consider the subject in all of its aspects and seek to remedy it.

There is a phase of this whole public relationship that seems to me to be slowly emerging, and that is that the United States will naturally divide itself into several power areas. For instance, the barren area of power consumption formed by the Adirondacks on the east and the character of natural resources along the Mason and Dixon Line on the South create a natural district in the New England and Middle Atlantic States. Another power district lies to the west of the Alleghanies and east of the Mississippi River. Still another district lies in the Southeastern States, again in the Southwestern States, and still another in the Northwestern States. The problems in each of these power districts are essentially different as to the origins of power, the character of their industries, and are affected by the rate of probable industrial development in some states. And if we are to make rightful solution of national problems, we should consider their development as essentially separate questions.

It is fitting that I should make some remark upon the remarkable progress and ability shown by the whole electrical industry since the days of Mr. Edison's initial genius. They have come to have a large vision of co-operation and service and have in very large measure realized their responsibilities to the public. One great mark of their progress is that despite the greatly increased cost of labor, coal and other materials, there is but little if any increase in the cost of light and power to the consumer today over prewar prices. Under the protection of state regulatory bodies over 2,000,000 of our people have invested their savings in this industry. From an annual utility production of 4,000,000,000 kw.-hr. twenty years ago we have increased to 50,000,000,000 today with an increase in consumption from 60 to 500 kw.-hr. per capita. It is a magnificent achievement of the initiative and ingenuity of these industries, and that it has attained such a growth under public regulation is itself proof of the ability and co-operation of our public officials. I believe that the same vision applied to the wider problems which spread before us will maintain the same initiative and secure like progress in the future.

Oil Storage Tanks

In view of the large storage of gasoline accumulated each winter by the refiners to meet the heavy summer demands, a considerable evaporation loss incurs. The loss consists not only of the direct removal of a portion of a tank's storage, but also, of the lowering of the gravity of the remainder by reason of the evaporation of the more volatile portions. The Bureau of Mines, in Report 2,531,

gives the result of investigation conducted in several types of storage tanks.

The report indicates that the completely sealed tank, when equipped with relief valve and vacuum breaker, is probably the most efficient. By this construction no circulation of air exists in the tank and consequently little gasoline vapor is lost. Tests were made on tanks fitted with water sprays, and the results indicated that, when properly installed, such a system will hold the tank at a practically uniform temperature, thereby avoiding breathing of the tank air due to temperature changes. Unless the water spray covers the side as well as the tank top, the results cannot be considered favorable. The water-sealed tank having the top covered with water is in general use, and tests show that, compared with the umbrella type, which has a screen placed over the tank top to prevent the sun's rays from striking the tank cover, the former shows an evaporation loss of one-third the loss in umbrella tanks.

The insulated tank having the sides plastered with insulating is in general use in the mid-continental field. The tank becomes in effect a thermos bottle, but unless it be kept cool, there will be more or less breathing. By allowing an air space between the tank and the insulation, it is possible to circulate cold air during the night, and the insulation will prevent heat absorption during the day if dampers are installed.

The conclusions arrived at are that cooling systems installed on tanks other than vapor-tight tanks are not effective and are believed to be a waste of money.

Water-seal roofs, by nature of their construction, insure a vapor-tight roof. The temperature of the vapors within the tank, however, cannot be less than the actual temperature of the water circulated over the roof.

Water sprays require a large amount of water, but they have a maximum cooling effect. The sides or shell of the tank should always be cooled by a water spray. In order to obtain the maximum effectiveness, water sprays should be so placed that wind and air currents will not carry the water from the tank roof, thus wetting one part of the roof only.

Installation for tanks is generally a permanent fixture. The initial cost may be rather high, but the operating cost is negligible. If tanks are insulated without an air space, gasoline to be stored in them should be pumped in at the lowest temperature practicable.

It is believed that types of insulation with an air space betwen the insulation and the tank are in general more satisfactory, for gasoline may be cooled in such a tank even though it be pumped in at a relatively high temperature.

Meeting of British Association for Advancement of Science

At this year's meeting of the British Association for the Advancement of Science, at Liverpool, Sept. 12 to 19, several papers[1] of interest to power plant engineers were presented.

Dr. H. Mawson contributed a paper on "Analytical and Experimental Investigations relating to Water Turbines." The first part dealt with an analytical method of predicting the form of the characteristic laws for a water turbine, the experimental verification of these and their application to the design, and the prediction of the laws for similar turbines. The second part gave analytical methods of estimating the rise of pressure in the pipe lines and the rise of speed of the turbine when the load was removed and the motion of the controlling vanes was known. The results were checked by experiments in which use was made of a timing device consisting of a vibrating tuning fork and pendulum controlled pens to obtain the variation in the above quantities after the load was removed.

A paper by Professor Cook upon "Stresses in Pipes Reinforced by Steel Rings," dealt with the additional strength that is gained in pipe lines for high heads of water in which steel rings shrunk on to the pipes at intervals are employed in place of excessively thick welds An investigation of the stress distribution in these pipes is given, while the effects of spacing and shrinkage of the bands are also analyzed. In large hydro-electric installations working under high heads the design of the pipe line presents considerable difficulties For a given discharge and head at the power station, considerable economy in material is effected by increasing the size and reducing the number of the pipes, but in a plain welded pipe a limit is imposed to the size by the maximum thickness that can be satisfactorily welded, which may be taken to be about 1¼ in. A type of construction recently introduced whereby large diameters may be used for high heads without an excessive pipe thickness consists in reinforcing the pipe by means of steel rings shrunk on at intervals along the pipe. The author had not been able to discover any published account of the method by which the strength of such pipes may be estimated.

Through the courtesy of the Chief Electrical Engineer to the Department of Public Service, City of Los Angeles, Calif., the author had been supplied with details of the dimensions of a reinforced pipe which forms part of the pipe line to the power station of that city. The internal diameter of the pipe was 80 in. and the thickness 0.63 in. The reinforcing rings are 4.45 in. wide by 1.575 in. thick and are spaced 11.05 in. center to center, leaving an unsupported length of pipe equal to 6.60 in. The working pressure is stated to be 642 ft. of water, or 278 lb. per sq.in. The author had no information regarding the amount of shrinkage allowed for the rings. The manner in which, according to this theory, the stress in the rings and the maximum stress in the pipe vary with the initial shrinkage is shown in Table I.

TABLE I—VARIATION OF STRESS WITH INITIAL SHRINKAGE

Initial Shrinkage, (In.)	Stress in Rings (Lb. Sq.In.)	Max. Stress in Pipe (Lb. Sq.In.)
0.000	8,780	9,450
0.002	9,500	8,750
0.004	10,230	8,060
0.006	10,950	7,360
0.008	11,680	6,670
0.010	12,400	5,970
0.013	13,490	4,930
0.016	14,570	3,880
0.020	16,020	2,490

Assuming a maximum working stress of 6 tons per square inch in the rings, the shrinkage would require to be 0.013 in., but under these conditions the maximum stress in the pipe, 4,930 lb. per sq.in., would appear to be unnecessarily small. The weight per foot of the reinforced pipe is 1,090 lb. The thickness of a plain pipe designed to carry the same pressure with a stress of 6 tons per square inch would be 0.842 in., and its weight 722 lb. per foot.

If a working stress of 6 tons per square inch be assumed for both the pipe and the rings, the working pressure may be 408 lb. per sq.in., and the shrinkage necessary 0.0014 in. To sustain this pressure a plain pipe would weigh 1,059 lb. per foot, which is still lighter than the reinforced pipe. It is, of course, evident that for a given maximum stress and pressure a plain pipe must have the advantage in weight owing to the fact that the stress is uniformly distributed through the material.

The possibility of allowing a higher working stress in the rings than would be safe for the pipe does, however, enable a reinforced pipe to be made lighter than a plain pipe, provided that the rings are sufficiently close together. This is shown by Table II, which gives the results of a calculation based on the dimensions of the Los Angeles pipe, assuming a stress of 10 tons per square inch for the rings

TABLE II—RESULTS OF CALCULATION BASED ON DIMENSIONS OF LOS ANGELES PIPE

Distance Between Rings (Clear) (In.)	Initial Shrinkage Required (In.)	Working Pressure (Lb. Sq.In.)	Weight per Foot—Reinforced Pipe (Lb.)	Weight per Foot—Plain Pipe, (Lb.)
3.0	0.0122	720	1,350	1,890
5.0	0.0131	628	1,180	1,645
6.6	0.0145	541	1,085	1,410
9.0	0.0187	448	988	1,170
12.0	0.0258	345	905	896
18.5	0.0394	209	800	536
25.1	0.0425	175	740	450
43.0	0.0395	209	595	536

[1] An abstract of Sir Ernest Rutherford's Presidential Address upon "The Electrical Structure of Matter" appearel in *Power*, Oct. 16, 1923.

and 6 tons for the pipe. In this table the pressure and the initial shrinkage required to produce these stresses are given for various distances apart of the rings, and the weights per foot of the reinforced pipe and a plain pipe to carry the same pressure with a stress of 6 tons per square inch. It will be seen that the spacing of the rings must be less than 12 in. in order to obtain a lighter pipe.

Professor Marchant, of Liverpool University, contributed two papers: "The Shape of the Voltage Waves of Alternators," and "Earth Currents flowing between the Neutral of an Alternator and the Sheath of the Cable." The former paper described an arrangement of shunts that can be used, especially on three-phase generators, when it is necessary to correct the wave shape of an alternator without rebuilding it. The essential features of the device are, first, shunts adjusted to have zero reactance for the ripples which it is desired to get rid of and, second, a limiting inductance arranged in the neutral of the three-phase supply, through which the shunt current produced by the ripple flows. The shunt circuit consists of an air core inductance and condensers arranged in series, the condensers being of fairly large capacity in order to reduce the voltage on them as much as possible. The limiting reactance in the neutral may be an iron core inductance. Curves are shown in which the method has been used on four machines with bad wave shapes. A demonstration of the device was given.

The second paper on earth currents stated that in some modern power stations it is found that there is a considerable current flowing through the ground lead from the neutral point of the alternator, even when only one machine is grounded. It has been found that the current so flowing is of three times (or a multiple of three times) the fundamental frequency. This current is due to a ripple in the pressure curve of the alternator between each phase and the neutral point. If such a ripple exists, a current corresponding with it will flow from each core of the three-phase cable network to the sheath, and the currents so passing, if they are of three times (or a multiple of three times) the fundamental frequency, add up and do not cancel each other, as do the three-phase capacity currents of fundamental frequency. Oscillograms of currents observed in the earth circuits of the neutrals of alternators in two large power stations were given in the paper.

Two papers upon methods of improving the health and efficiency of the workers in coal mines may be mentioned.

The first of these was contributed by Professor Thornton to the Engineering Section on Wednesday, Sept. 19, and was entitled "A Safe Method of Lighting Coal Mines." The author in this paper stated that the remarkable increase in the number of cases of nystagmus among coal miners, known to be produced by imperfect lighting at the coal face, calls for improved methods of illumination. The direction in which this has been hitherto sought is by the use of more powerful portable low-voltage electric lamps. The maximum voltage permitted at the face for signaling purposes is 25, direct or alternating, and with this unarmored cab-tire flexible cables may be used. An evident method of improving illumination is to use 25 volts with fixed or portable lamps. The objections raised to any such scheme are solely those of ignition, since shock is impossible at such voltages and the circuits are non-inductive.

Recent observations on the influence of frequency on the ignition of methane (firedamp) show that by use of much higher frequencies than those now employed for power purposes a higher factor of safety can be obtained. For example, ignition of the most explosive mixture of firedamp in air (9.5 per cent) by the break of a 200-volt direct-current circuit occurs at 0.5 ampere. At a frequency of 50 the least igniting current is 6.5 ampere, while at 160 it rises to 23 amperes. At a voltage of 20 and a frequency of 160 it is impossible to ignite this mixture with a clean break of less than 150 amperes. Now the currents taken by 15-watt gas-filled lamps suitable for use at the face do not exceed 1 ampere.

A system now being tested consists of a 160-frequency supply at 15 volts, each circuit having about twenty portable lamps. These have double filaments the shorter of the two, connected to the battery contained in the lamp, gives 2 candlepower, by which the miner travels. The larger one carries 15 volts, by which, when connected to a plug housed in a heavy movable block, the illumination at the working face can be raised to 15 or more candlepower, the shorter filament being then cut out. In the case of failure of supply, work can be continued on the lamp battery. Each plug has a special interlocking contact by which a break of circuit is prevented until the lamp is switched over on to the portable cell. There is therefore no risk of open sparking. The plug box also contains a fuse, by which, in the event of a short-circuit in a lamp, that alone is cut out. The less likely case of a short-circuit on the main heavy cab-tire flexible cable which runs through all the plugs is provided for by a choking coil permanently in circuit, which limits the current to less than that which could cause ignition of a 9.5 per cent mixture if broken in the open. The system is therefore protected by all the usual devices against excess current, but its chief safety is in the use of currents of such frequencies that, without any other change, the factor of safety is raised to a high value.

Description of a Dust Explosion*

Industrial-plant dusts do not explode in the same manner as dynamite, gunpowder and other high explosives; they explode in the same manner as gas or inflammable vapors. The dust must be in suspension in the air as a cloud, mixed with air in proper proportions, just as gas and air must be mixed in proper proportions in the cylinder in an internal-combustion engine. The mixture of dust and air will not explode until it comes in contact with a flame or some other source of heat of sufficient intensity to cause it to ignite.

The dusts from any material that burns will explode under favorable conditions. The ease of ignition, of course, depends on certain factors, such as composition and fineness of the material and the quantity of moisture in the dust. As a rule if the dust is sufficiently fine and dry enough to form a cloud or to be thrown into suspension in the air, it will be ignited, producing an explosion.

In industrial-plant dust explosions a series of reports resembling a roll of thunder is usually heard, probably because several explosions follow one another so rapidly that the report of one blends in with that of the next, making a continuous roar. The concussion that accompanies the original or primary explosion shakes the accumulated dust into suspension and permits the explosion to spread throughout the entire plant area or as far as the dust is held in suspension.

In order to prevent dust explosions and fires effectively, it is essential not only that all possible sources of ignition be eliminated, but also that the plant be kept clean, thus removing the medium through which the primary explosion may spread into the secondary and more violent explosion.

It would seem almost unnecessary to refer to the great importance of effective methods for dust removal and plant cleanliness. The extent of dust explosions, however, has been very closely related to the quantity of dust that has accumulated throughout the plant at the time of the primary ignition. Before an explosion or fire can take place, something to explode or burn must be present and enough dust to allow the flames to spread must be in suspension in the air.

No matter how well the plant is constructed, it must be well kept. A well-constructed plant built of fire-resistive materials in which dust has been allowed to accumulate and the upkeep of which has been neglected is a greater hazard than a plant built of combustible materials but well cared for and provided with effective dust-control devices. We must, of course, continue to embody the best principles of construction, but in addition we must install equipment for effective dust removal. It is gratifying to note that marked progress has been made in developing pneumatic sweeping systems for the removal of static or settled dust in industrial plants.

*From a paper read by David J. Price, engineer in charge development work, Bureau of Chemistry, Department of Agriculture, before the International Fire Prevention Congress, New York City, Oct. 10.

News in the Field of Power

Big Creek No. 3 Plant Placed in Service

Largest Single Hydro-Electric Plant on Pacific Coast Forms Part of Million Horsepower Project

THE largest and latest plant of the Big Creek and San Joaquin River project of the Southern California Edison Co., known as Big Creek No. 3, was placed in operation Oct. 11. This plant is susceptible of being doubled in capacity when the great Florence Lake tunnel, the longest water-power tunnel in the world, is completed, some two years hence. This tunnel will be more than twice as long as the Rogers Pass tunnel on the Canadian Pacific Railway, which is at present the longest tunnel on the American Continent, and it will be more than a mile longer than the Simplon tunnel through the Alps in Switzerland, which pending the completion of the Florence Lake tunnel is the longest in the world.

Big Creek No. 3 has three 35,000-hp. units operating under a 760 ft. head. These are supplied by diversion of the waters of the San Joaquin River through a tunnel six miles long. Current is transmitted 275 miles at 220,000 volts.

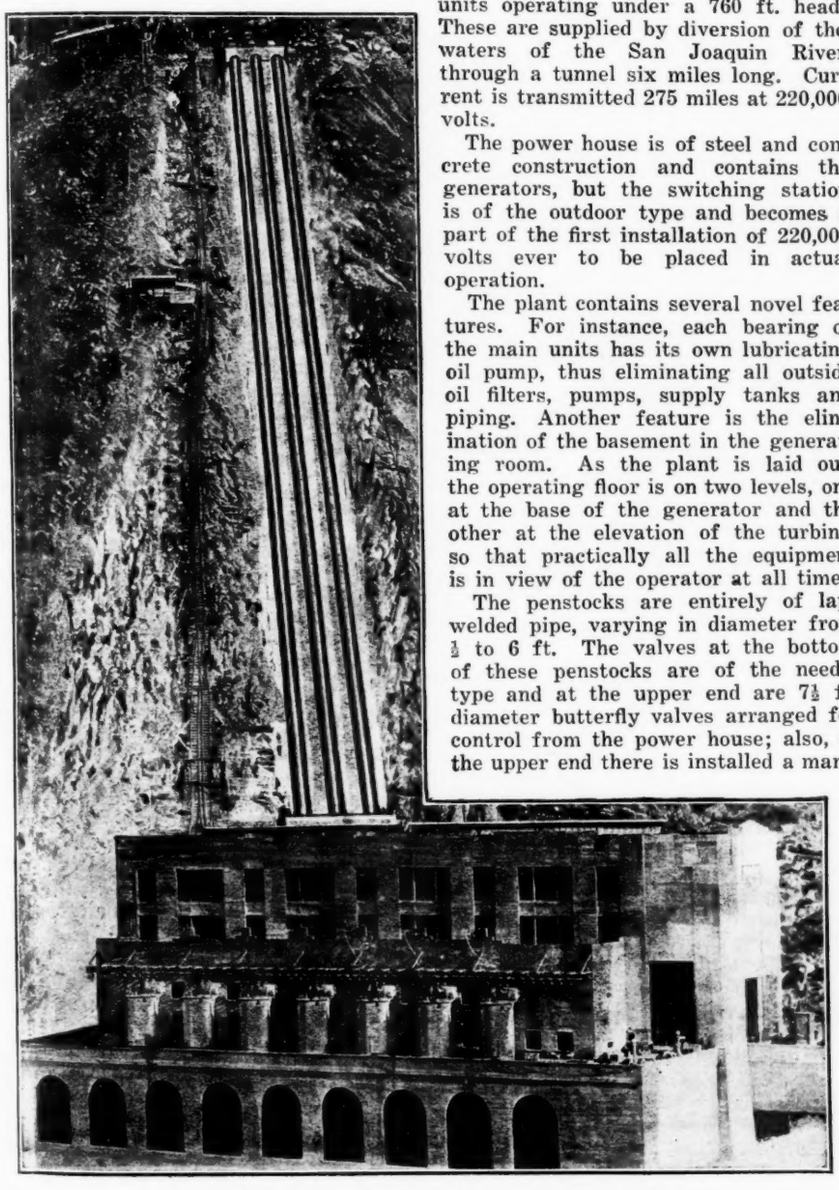
The power house is of steel and concrete construction and contains the generators, but the switching station is of the outdoor type and becomes a part of the first installation of 220,000 volts ever to be placed in actual operation.

The plant contains several novel features. For instance, each bearing of the main units has its own lubricating oil pump, thus eliminating all outside oil filters, pumps, supply tanks and piping. Another feature is the elimination of the basement in the generating room. As the plant is laid out, the operating floor is on two levels, one at the base of the generator and the other at the elevation of the turbine, so that practically all the equipment is in view of the operator at all times.

The penstocks are entirely of lap-welded pipe, varying in diameter from ½ to 6 ft. The valves at the bottom of these penstocks are of the needle type and at the upper end are 7½ ft. diameter butterfly valves arranged for control from the power house; also, at the upper end there is installed a manifold of special design, which connects the six penstocks of the ultimate installation with an 18-ft. steel pipe leading from the tunnel. At this location there is also installed a surge tank excavated from the solid rock. This is shaped similar to an hour glass, the largest portion being 75 ft. in diameter.

There will be an additional plant constructed directly below the No. 3 plant, utilizing all the remaining available head in the Grand Canyon of the San Joaquin River. In addition to these five generating stations there will be some ten stations constructed to utilize the waters coming from other tributaries of the San Joaquin River.

On this development there is a total potential power, which the company proposes to develop within the next ten years, of approximately 1,107,000 hp. These plants will utilize the waters of the entire drainage area from Mt. Hilgard, on the crest, to the San Joaquin Valley, or a total drop of two miles.



BIG CREEK NO. 3 POWER HOUSE AND PENSTOCKS

Standard Oil Buys Diesels

The Standard Oil Co. has placed an order for 16 Diesel engines with the McIntosh & Seymour Corp., Auburn, N. Y. These engines, which are of the trunk-piston marine type, are to be used in oil tankers.

Flanges for High Pressures To Be Standardized

As a direct result of the informal conference on high-pressure flanges, which was held in the Engineering Societies' Building, New York, on May 23, a new subcommittee has been organized to draft flange standards for pressures over 250 lb. per sq.in. and the corresponding superheats. This committee is a subcommittee of the Sectional Committee on the Standardization of Pipe Flanges and Fittings, Prof. C. P. Bliss, chairman, which was organized in October, 1921, under the rules of procedure of the American Engineering Standards Committee. The sponsors for this sectional committee are: Committee of Manufacturers on Standardization of Fittings and Valves, Heating and Piping Contractors National Association, and The American Society of Mechanical Engineers.

The organization meeting of this subcommittee has been set for Oct. 26, at 10 a.m. It will take the form of an open meeting to which all will be welcome and permitted to present their views on the standardization of pipe flanges and flanged fittings for steam pressures over 250 lb. per sq.in. Chairman Bliss will preside.

F.A.E.S. Discusses Important Legislation

President Cooley To Resign—Congressional Investigation of Davis Removal Recommended—Action on Public Works Department Urged—Ferris Amendment Indorsed

AT THE meeting of the Executive Board of the American Engineering Council of the F.A.E.S., held in Rochester, N. Y., on Oct. 12-13, matters of more than ordinary interest to the engineering profession were considered.

Dean Mortimer E. Cooley announced his determination to terminate his tenure of the office of president of the F.A.E.S., which has still a year to run, giving ill health as the reason for this step. The Board expressed its deepest regret at this decision and embodied its appreciation of the services that he had rendered the Society in a sincere and appropriate resolution.

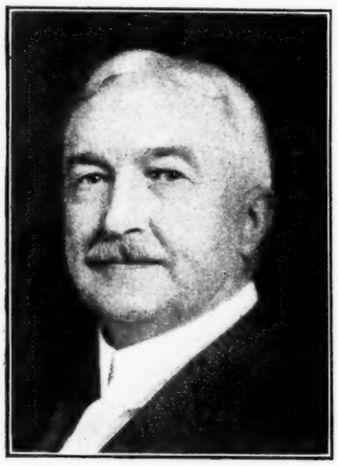
The Board authorized that the letter, formulated by its Committee on Public Affairs in joint session with the Special Committee of the A.S.C.E., on the removal of A. P. Davis as director of the Reclamation Service be sent to Secretary Work. The points emphasized in the letter were: That an engineer and business man are not necessarily two distinct individuals; that particularly in operations where engineering plays a large part, the executive or business man is better capable of filling the position if he has an engineering training; that problems of engineering did not cease with the finishing of a project; that, further, should any engineer or any technical employee of the government, occupying an important and responsible position, be dismissed arbitrarily without any other reason being given than that he has not business ability, and without a proper hearing at which charges may be brought against him at which he may have the opportunity of refuting? It was explained that the purpose was not to reinstate Mr. Davis, who is now employed at two or three times the salary that the government was paying.

In addition to the letter the Joint Committee considered it advisable to advise the F.A.E.S. and A.S.C.E. that the committee would recommend that a Congressional investigation be made of this matter and that the various engineering societies throughout the country use their influence with their Congressmen and Senators, to explain the situation to them and to acquaint them with the general underlying facts.

Dean F. F. Walker reported for the Committee on Coal Storage that the secretary's report would deal with how coal may be stored in consideration of its physical and chemical characteristics, method of storage, physical means, equipment, costs, etc.

Philip N. Moore, of St. Louis, introduced a resolution reviving the Public Works campaign, which was passed unanimously, summarized briefly as follows:

The engineers of the United States, together with the architects and contractors organized in the National Public Works Department Association, for several years led a campaign to change the Department of the Interior into a Department of Public Works to which should be transferred all the non-military engineering and construction functions of the government, and introduced into both houses of Congress the bill known as the Jones-Reavis bill. Activity in support of the bill was stopped upon representation that this plan would be included in a general reorganization plan for government departments. This large and comprehensive plan now promises to meet with delay and opposition, but there seems no such serious opposition to the reorganization of the Department of the Interior alone. It was decided to appoint a special committee to draft and to introduce into Congress a bill carrying into effect that portion of the reorganized plan prepared by the Joint Committee of the House and Senate, under the chairmanship of Walter H. Brown, which deals with the Department of the Interior.



MORTIMER E. COOLEY

It was also decided to devote a day in connection with the meeting of the American Engineering Council at Washington in January to the discussion of the Department of Public Works; all organizations of engineers and contractors to be invited to send representatives; all eligible to membership in the F.A.E.S. to be invited to attend the other meetings of the Council with privilege of the floor.

The Board gave its unanimous approval of the proposed New York State Constitutional (Ferris) Amendment which goes before the voters of New York State on Nov. 6 It was the opinion of the Reforestation Committee that, as the New York State Constitution now reads, it is impossible to cut trees in the forest preserves and that in consequence proper and modern methods of forest preservation and care cannot be accomplished unless these laws are altered.

The next meeting of the Board will be Jan. 9 at Washington, D. C., and that of the American Engineering Council Jan. 10-11 at the same place.

Explosion of Coal-Dust Particles To Be Studied

A study of the time rate of explosion of coal-dust particles will be made by the Department of the Interior in cooperation with the Carnegie Institute of Technology at the Pittsburgh experiment station of the Bureau of Mines. J. Malcolm Pratt, research fellow, has been assigned to the problem, and will work under the supervision of C. M. Bouton, associate research chemist. The first part of the problem is to develop an apparatus by which coal-dust particles of definite size can be obtained.

N. Y. State May Withdraw Suit Against Water Power Act

There are indications that the State of New York will withdraw its suit against the government, in which it threatened to test the constitutionality of the water-power act. The Department of Justice recently made informal inquiry as to whether or not the State of New York would consent to withdraw its suit without prejudice. The reply is understood to have indicated that the decision in the matter could not be reached until May. This and other indications lead to the belief that the state will withdraw its suit at that time.

Boiler Code of India Differs from the A.S.M.E. Code

It has previously been noted in *Power* that a uniform boiler code for the various states of India was in process of preparation. A communication, which the A.S.M.E. Boiler Code Committee recently received, from A. Lennos Stanton, mechanical and electrical engineer at Bombay, India, states that the code is now finished and will go into effect Jan. 1, 1924. While this code is based largely on the A.S.M.E. Code, Mr. Stanton desires to call the attention of American boiler manufacturers to the fact that there are enough differences, so that boilers constructed in accordance with the A.S.M.E. Code might fail to meet the new conditions imposed. It is therefore, important, he says, that American manufacturers exercise discretion in meeting stock orders from agents in India if those stocks were liable to be unfilled by the first of January, 1924. While copies of the new regulations have not yet been received, they are expected shortly and will be obtainable from O. W. Obert, Sec. Boiler Code Committee, A.S.M.E., 29 West 39th St., New York City.

Oil Burner Manufacturers Form Association

At a recent meeting held at Chicago of oil-burner manufacturers from all over the United States, there was formed the American Association of Oil Burner Manufacturers. The purpose of this new organization is to inform the public of the comfort and convenience of oil burners for domestic uses as well as the merits and advantages of industrial oil burners.

Wallace C. Capen, Home Appliance Corp., St. Louis, was elected president of the association, and Leod D. Becker was elected secretary-treasurer. The association will have temporary headquarters at Chicago.

Management Week Observed by Engineers

Under the direction of representatives of five national organizations, the A.S.M.E., The Taylor Society, the society of Industrial Engineers, the National Association of Cost Accountants and the American Management Association, meetings are being held this week by local sections of these societies and other organizations all over the country, spreading the ideals of better management. In New York City, where the General Management Association is holding its annual meeting, a dinner meeting on Oct. 30 will be devoted to the "Stabilizing Prosperity in America," at which Willis H. Booth, David Friday and John Hays Hammond will speak.

Edison Companies Object to Wrong Use of Designation

At the recent convention of the Association of Edison Illuminating Companies at Dixville Notch, N. H., it was pointed out by some of the executives present that several electric utilities not rendering Edison service were incorporating the word "Edison" in their corporate names. It was pointed out that this was misleading. The association felt so strongly on the matter that, following the report of a committee consisting of Samuel Insull (chairman), C. L. Edgar and J. W. Lieb, the following resolution was unanimously adopted:

Whereas, It has come to the attention of the Association of Edison Illuminating Companies that in the incorporation of various companies throughout the United States for the creation, merger or combination of public utilities there is a growing tendency to make use, without apparent authority, of the name "Edison"; and

Whereas, It is evident that the chief purpose of such use of the name "Edison" is to mislead by taking advantage of the significance which the name has acquired, in the first place from the illustrious achievements of Mr. Edison himself, which have made the name a household word in this country, and in the second place from the position enjoyed by the member companies of this association, which, striving from the first for the very highest standards in the electric light and power industry, have won the public's confidence and good will as reflected in the high place their securities hold in the esteem of the investing public; and

Whereas, Such unauthorized use of the name "Edison" is unfair both to the members of this association, which have contributed so much to maintaining the significance of that name, and to the investing public;

Now, therefore, be it resolved, That the officers and the executive committee of this association be, and they are hereby, directed to take such steps as may be practicable to stop further unauthorized use of the name "Edison," and that the member companies of this association in localities where such unauthorized use may occur be, and they are hereby, urged to do whatever may be in their power to aid and make effective the efforts of the officers and the executive committee with respect to carrying out the purpose and intent of this resolution.

Giant Relief Map Shows Power Developments of Georgia

The abundant hydro-electric power available in north Georgia and the advantages that this offers to new industries seeking suitable locations will be shown graphically by a giant relief map which will form a part of the Georgia Railway & Power Co.'s exhibit at the International Textile Exposition to be held in Mechanics' Hall, Boston, Mass., from Oct. 29 to Nov. 3.

This relief map shows the developments that the power company has made or is making along the Tallulah, Chattanooga and Tugalo Rivers in the section, and takes into account an area of something like seventy square miles.

Dams, power plants, transmission lines, artificial lakes and projects now under construction are faithfully portrayed on this map, which shows the power plants that now supply more than fifty cities in Georgia and that will supply as many more when the projects now under way are completed.

Twelve States Have Reciprocal Registration of Engineers

Reciprocal registration of engineers in twelve states that have laws regulating the practice of engineering is an established fact. Reports at the meeting in Chicago, recently of the Council of State Board of Examiners, indicated that Arizona, Florida, Oregon, Minnesota, North Carolina, South Carolina, Louisiana, Michigan, Iowa, West Virginia, Indiana and Colorado had ratified the articles of agreement on the subject adopted by the Council at last year's meeting. It is a plan to reflect in the examination for a reciprocal "card" a standard even higher than that required by any one of the states in the Council. The cards, which were printed by the Council and made available for the first time at the meeting, are the means of certification of the applicant's qualification from one state to another.

In the states accepting the agreement the card will be *prima facie* evidence of an engineer's qualification for a license in that state, but it does not waive legal fees or such information other than evidence of qualification as required to conform to the rules of the examining board.

Reciprocal relations with Mexico and Canada are under consideration by the Council. A. B. Carter, Oregon, stated that his state has established reciprocal relations with British Columbia and Alberta.

Smoke Abatement Studied by Osborn Monnett

Activities suspended during the war by civic authorities and organizations in the campaign to eliminate the smoke nuisance are being renewed, according to a report following a study of the smoke abatement made by Osborn Monnett, for the Bureau of Mines and published by them as Technical paper No. 273.

Five-sixths of the coal mined in the United States is bituminous, or soft coal, containing a large proportion of volatile matter which makes smoke if not properly burned; that is, if not enough oxygen is supplied to burn completely the hydrocarbons. These hydrocarbons, if not burned, condense as soot, which is precipitated on heating surfaces, and as smoke, which escapes into the surrounding atmosphere. This deposit of soot on the heating surface of boilers and furnaces causes a serious economic loss by interfering with the efficient transmission of heat from the fire to the boiler or heater. In addition the smoke escaping causes considerable loss through damage to fabrics and merchandise, necessitating extra cleaning and repairs, and is distinctly detrimental to the health of people suffering from lung or throat trouble.

High-pressure plants contribute about 45 per cent of the total smoke of the average city. Most of these plants are hand-fired and consist of small units, approximately 150 hp. each. Fires in hand-fired furnaces, using the theory of smokeless combustion, are generally replenished by the alternate method; that is, by firing one side at a time and meanwhile admitting auxiliary air over the fire as the excess volatile matter is passing off. The heat from the other side of the fire supplies the temperatures necessary for completing combustion. Fires should be started from above; that is, a layer of paper should be placed over a bed of coal and then kindling placed above the paper. Power plants equipped with acceptable hand-fired furnaces properly operated can easily run inside a smoke density of 2 to 4 per cent.

Stoker-fired plants have been more successful in smoke abatement as the boiler units are generally large size, have been carefully designed and skilled engineers are always in attendance to watch them.

It is stated that any operation requiring fuel can be conducted without objectionable smoke, and yet use bituminous coal in some form.

Electrical and Industrial Exposition Opens

The Sixteenth Annual Electrical and Industrial Exposition opened on Oct. 17 at the Grand Central Palace, New York City. The New York Edison Co., in honor of the event, invited Thomas Alva Edison and a party of guests, together with representatives from the Electrical Board of Trade of New York, to view, at the Forty-eighth Street Theater, the first exhibition of a moving picture, entitled "At Your Service," showing the methods of generating electric current and some of its applications in the service of the New York Edison Co.

Charles L. Eidlitz, of the Electrical Board of Trade, delivered an address honoring Mr. Edison's achievements, and John W. Lieb gave an interesting outline and explanation of the pictures which started with the mining of the coal, its transportation by cars, boats, trucks and hoisting machinery, under varying weather conditions, until it finally reached its destination in the mechanical stokers of Waterside Nos. 1 and 2, and Hell Gate stations. All the intricate operations of the installation, transmission and control of the current, by multitudinous switches was given in detail.

Mr. Average Citizen's use of the electrical appliances for comfort and labor saving were shown as actually used from the early morning facial massage of Mr. A. C., through the middle of the day when baby and dog get into mischief and appliances are hastily brought into play, up to the final turning out of the lights by the maid after the after-theater supper cooked on the electrical chafing dish. Hearty applause greeted the picture of Mr. Edison, which concluded the entertainment. Preceding the picture a luncheon was given by the New York Edison Co., at the Biltmore, in honor of Mr. Edison, at which about 200 covers were laid.

Society Affairs

The A. I. E. E. will have an especially interesting feature at its Midwinter Convention in the celebration of the 40th anniversary. Talks will be given by founder members of the Institute on historical reminiscences of the early days of the A. I. E. E.

The Western Society of Engineers is observing management week by holding two meetings. A dinner meeting on Oct. 25 will have as its topic, "Non-Mechanical Means of Increasing Man-Power." W. L. Abbott, of the Commonwealth Edison Co., is to be chairman, and J. D. Cunningham, Republic Flow Meters Co., will speak on "Engineering Methods of Increasing Man-Power"; Hugo Diemer, La Salle Extension University, on "Industrial Relations and Personnel Work as a Means of Increasing Man Power"; William B. Castenholz, certified public Accountant, on "How Accountants Help Executives Increase Man-Power"; H. N. Stronck, Arthur Andersen & Co., on "Organization and Control as a Means of Increasing Man-Power."

The American Academy of Political Science will hold a conference on "The Government, The People, and The Price of Coal" (including both bituminous and anthracite), at Philadelphia, Nov. 16-17. The topics for discussion will be: "Wages and Hours of Labor in the Coal Industry"; "Efficiency and Costs in Mining Coal"; "Wages and Anthracite Coal Prices as Viewed by Miners and Operators"; "Costs and Profits in Mine Production and in the Distribution of Coal"; "Substitutes for Coal and Giant Power"; "The Way Out."

Coming Conventions

The American Association for the Advancement of Science. Burton E. Livingston, Smithsonion Institution Bldg., Washington, D. C. Seventy-fifth anniversary meeting at University of Cincinnati, Cincinnati, Ohio, Dec. 27-Jan. 2.

The American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Midwinter convention at Philadelphia, Feb. 4-8.

American Society of Mechanical Engineers, Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Dec. 3-6. Regional meeting at Chattanooga, Tenn., Oct. 23-24.

American Society of Refrigerating Engineers, William H. Ross, 35 Warren St., New York City. Nineteenth Annual Convention at New York City, Dec. 3-5.

The American Society of Safety Engineers. Genevieve S. Wood, 29 West 39th St., New York City. Annual meeting at New York City, Jan. 18.

American Welding Society. M. M. Kelly, 33 West 39th St., New York City. Fall Meeting, Pittsburgh, Pa., Oct. 24-26.

Association of Railway Electrical Engineers. Jos. A. Andreucetti, Room 413, Chicago & Northwestern R.R. Station, Chicago, Ill. Thirteenth Annual Convention at Hotel La Salle, Chicago, Ill., Nov. 6-9.

Electric Power Club. S. N. Clarkson, 900 B. F. Keith Bldg., Cleveland. Fall meeting at French Lick Springs Hotel, French Lick, Ind. Nov. 19-22.

National Association of Practical Refrigerating Engineers; Ed. H. Fox, 5707 W. Lake St., Chicago. Fourteenth Annual Convention at Memphis, Dec. 12-16.

National Exposition of Power and Mechanical Engineering; Charles F. Roth, Room 1102, Grand Central Palace, New York City. Power Show, Dec. 3-8.

National Marine Engineers' Beneficial Association. Geo. A. Grubb, 313 Machinists' Bldg., Washington, D. C. Annual Convention at Franklin Square Hotel, Washington, D. C. Jan. 21-26.

New England Association of Commercial Engineers; James F. Morgan, 53 Devonshire St., Boston, Mass. Power Show at Mechanics Bldg., Boston, Mass., Oct. 29-Nov. 3.

Society of Automotive Engineers, Coker F. Clarkson, 29 West 39th St., New York City. Annual meeting at General Motors Bldg., Detroit, Mich., Jan. 22-25.

Society of Naval Architects and Marine Engineers. Daniel H. Cox, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 8-9.

Trade Catalogs

Turbine—Moore Steam Turbine Corp., Wellsville, N. Y. Bulletin 1926 describes the use of the Moore turbo-alternator units acting as a power generating reducing valve.

Pumps, Oil—Manzel Brothers Co., 309 Babcock St., Brooklyn, N. Y. Booklet No. XN 423 describes, with illustrations, the working and construction of force sight feed oil pumps.

Stokers, Mechanical—McClave Brooks Co., Scranton, Pa., Catalog covering mechanical stokers for all grades of bituminous and lignite fuels. Illustrations and descriptions as well as the new form of loose-leaf binder add to the attractiveness of this catalogue.

Boilers, Return Tubular—Bass Foundry and Machine Co., Fort Wayne, Ind., Bulletin B. D. contains 32 pages of descriptions and illustrations, tables of measurements of settings, plans of settings and other information in regard to the boilers manufactured by this company.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Oct. 8, 1923	Oct. 15, 1923
Pool 1,	New York	$3.00@3.25	$3.00@3.25
Smokeless,	Columbus	2.85@3.25	2.85@3.25
Clearfield,	Boston	1.85@2.50	1.50@2.50
Somerset,	Boston	2.00@2.75	2.00@2.75
Kanawha,	Columbus	1.75@2.00	1.75@2.00
Hocking,	Columbus	1.75@2.00	1.75@2.00
Pittsburgh No. 8	Cleveland	1.90@2.00	1.85@1.95
Franklin, Ill.	Chicago	2.25@3.00	2.25@3.00
Central, Ill.	Chicago	2.00@2.25	2.00@2.25
Ind. 4th Vein,	Chicago	2.50@2.75	2.50@2.75
West Ky.,	Louisville	1.50@2.00	1.50@2.00
S. E. Ky.,	Louisville	1.75@2.25	1.75@2.25
Big Seam,	Birmingham	1.75@2.15	1.75@2.15

FUEL OIL

New York—Oct. 18, light oil, tank car lots, 28@34 deg Baumé, 3¾c. per gal., 36@40 deg. 4c. per gal., f.o.b. Bayonne, N. J.

Chicago — Sept. 28, 24@26 deg. Baumé, $1.82@2.07 per bbl.; 32@36 deg., $2.02@2.07 per bbl., tank cars.

St. Louis—Oct. 9, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.60 per bbl.; 26@28 deg., $1.65; 28@30 deg., $1.75; 32@36 deg., gas oil, $1.85; 36@40 deg., distillate, 4¾c. per gal.

Pittsburgh—Oct. 18, f.o.b. local refinery, 30@34 deg., fuel oil, 5½c. per gal.; 36@40 deg., fuel oil, 5¾c.; 34 deg., neutral 8c.

Dallas—Oct. 13, f.o.b. local refinery, 26@30 deg., $1.35 per bbl.

Cincinnati—Oct. 16, tank-car lots f.o.b. local refinery, 26@30 deg. Baumé, 5c. per gal.; 30@32 deg., 5¼c.; 38@42 deg., distillate, 6½c.

Philadelphia—Oct. 12, 26@28 deg., $1.68@1.722 per bbl.; 16@20 deg., $1.64 @1.68; 14@16 deg., $1.57@1.612.

New Plant Construction

PROPOSED WORK

Ala., Birmingham—A. Sherrod, High Point, N. C., is president of a company that plans to build an ice plant on a 120 x 150 ft. site, here. Estimated cost $100,000. Electrically driven ice machinery will be installed.

Ala., Florence—The city plans to change its present steam pumping plant to electric drive, capacity 1,000 g.p.m. Estimated cost $30,000.

Calif., Corcoran—Reclamation Dist. 825, c/o A. D. Schindler, Consult. Engr., Balfour Bldg., San Francisco, is having plans prepared for the construction of levees, canals, ditches and the installation of pumping plants, here. Cost will exceed $3,000,000.

Calif., Eureka—Humboldt County, F. M. Kay, Clk., plans to build a refrigerating plant for the county hospital.

Calif., Los Angeles—F. E. Keeler et al., Pacific Mutual Bldg., are having preliminary plans prepared for the construction of a store and office building on 5th and Hill Sts. Cost will exceed $750,000. Curlett & Beelman, Union Bank Bldg., Los Angeles, Archts.

Calif., Mare Island—The Bureau of Yards & Docks, Navy Dept., is receiving bids on Specification 4717, including two 50,000 bbl. fuel oil tanks; three motor driven, centrifugal oil pumps; one motor driven, centrifugal pump for fresh water; one motor driven foam chemical agitating pump; air compressors; foam solution tanks on steel towers; earth embankments around fuel oil tanks; three pump houses; tank heater house; valve chambers; catch basins; piping valves and fittings.

Calif., Presidio (San Francisco P. O.)—The Constructing Quartermaster, Fort Mason, will receive bids until Nov. 5 for the installation of pump and motor and the construction of an addition to pump house.

Calif., Sacramento—The Southern Pacific R.R. Co., 65 Market St., San Francisco, is having plans prepared for the construction of a union passenger depot, here. Estimated cost $1,000,000. Bliss & Faville, Balboa Bldg., San Francisco, Archts. Equipment detail not reported.

Calif., San Francisco—The city and county of San Francisco have had plans prepared and will receive bids about Feb. 1, 1924, for the construction of six 2, 3 and 4 story hospital buildings. Estimated cost $1,750,000. J. Reid, Jr., 1st Natl. Bank Bldg., San Francisco, Archt. Equipment detail not reported.

Calif., Santa Barbara—The Southern California Edison Co., 306 West 3rd St., Los Angeles, is having plans prepared for the construction of a transformer station on Montecito St., here. Cost will exceed $75,000. Private plans.

Calif., Turlock—The Turlock Irrigation Dist., A. Sorensen, Secy., will receive bids until Oct. 29, for the construction of canal enlargements, canal lining, drainage wells, pumps and electrical distribution lines.

Calif., Willows—The Glenn County High School Dist. is in the market for a Byron-Jackson pump for high school water system. Estimated cost $1,500.

Fla., South Jacksonville (Jacksonville P. O.)—The Leesburg Fibre Pulp & Paper Co., Leesburg, G. D. Leach, Secy., plans to build a paper mill including 50 x 300 ft. main building, beater rooms, machine shops, power house, sorting, rotary cooking and pulp tankage departments, etc., here. Estimated cost $500,000.

Fla., Stuart—The Florida Food Products, Inc., C. J. Earley, Treas., P. O. Box B 3, plans to build a plant for the manufacture of ice, jams, jellies and preserves and for refining cane syrup, including power plant. Initial cost, including machinery, $90,000. The owner is in the market for power machinery.

Fla., Tampa—The Interstate Investment Co., Citizens Bank Bldg., J. T. Swann, Vice-Pres., is having plans prepared for the construction of a group of buildings including cold storage warehouse. Estimated cost $1,000,000. Lockwood, Greene & Co., 1530 Healey Bldg., Atlanta, Ga., Engrs. and Archts.

Ga., Augusta—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., plans to build a group of buildings for the United States Veterans' Hospital, here.

Ga., Austell—C. J. Shelverton is in the market for a 125 hp. engine and a 150 hp. boiler.

Ga., Woodbury—The city, c/o Mayor, plans to rebuild its electric light plant which was destroyed by fire. Loss $10,000.

Ill., Chicago—The W. L. Steege Electric Co., 526 West Van Buren St., is in the market for a 25 hp., 3 phase, 60 cycle motor.

Ill., McLeansboro—The City Clerk, City Hall, will receive bids until Nov. 3 for pipe, special castings, five gate valves, fire hydrants, 400,000 g.p.d. filter plant, pumping equipment, etc. Estimated cost $31,500. W. A. Fuller Co., 1917 Railway Exch. Bldg., St. Louis, Engrs. Noted Sept. 25.

Kan., Fredonia—The Kansas Gas & Electric Co., c/o K. P. Horine, is having plans prepared for the construction of substations here and at Buffville, also a 60,000 volt transmission line from here to Cherryvale. Estimated cost $100,000. Private plans.

Ky., Louisville—B. B. Davis, Archt., Norton Bldg., is receiving bids and will open same about Nov. 10 for the construction of a 12 story, 124 x 150 ft. hotel on 5th and Walnut Sts. for the Citizens Hotel Co. Estimated cost $2,300,000. Equipment detail not reported. Noted May 15.

Ky., Louisville—The Office of the United States Engineer, P. O. Box 72, is in the market for machinery, including main and swinging engines, dippers, A frames, etc., for two dredges.

La., Leesville—The city is having plans prepared and will soon hold an election to vote $225,000 bonds for waterworks system, electric light and sewers. E. T. Archer & Co., 609 New England Natl. Bank Bldg., Kansas City, Mo., Engrs.

La., New Orleans—The Office of the United States Engineer, 329 Customhouse, will receive bids until Nov. 2 for furnishing one 24 in. dredge pump and suction mouth.

Me., Sanford—G. A. Byers, c/o F. Goodwillie, Engr. and Archt., 56 West 45th St., New York, is having sketches made for the construction of a 5 story, 100 x 150 ft. hotel, here.

Md., Baltimore—The Consolidated Gas, Electric Light & Power Co., Lexington Bldg., H. A. Wagner, Pres., plans to build a power plant on Gould St. Estimated cost $4,000,000.

Md., Baltimore—G. R. Debman, Jr., Union Trust Bldg., plans to build a 15 to 20 story, 75 x 184 ft. office building on Charles and Chase Sts. Estimated cost $1,000,000. Engineer or architect not selected.

Mass., Boston—The city is having plans prepared for the construction of a hospital on Harrison Ave. Estimated cost $3,000,000. Ritchie, Parsons & Taylor, 15 Ashburton Pl., Boston, Archts. Equipment detail not reported. Noted June 26.

Mich., Grand Rapids—The city, W. A. Sperry, Dir. of Public Service, will receive bids until Nov. 8 for the construction of extension to filter house, motor room, laboratory, three gate houses, etc. R. E. Harrison, Engr.

Minn., Litchfield—The city, M. Mortenson, Recorder, awarded the contract for the construction of a power house to Anderson Bros., Litchfield, $29,245; chimney; also 500 kva. steam engine driven generating unit, switchboard, boiler plant, piping, including 250 hp. water tube boiler and stoker to J. G. Robertson, 2543 University Ave., St. Paul, $5,085 and $66,137 respectively; water softening plant for boiler feed, 24,000 g.p.d. to the Wayne Pump & Tank Co., 1311 Hennepin Ave., Minneapolis, $2,280; wells and piping to J. F. Coyle, Sauk Center, $5,250. Noted Sept. 25.

Miss., Gulfport—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., L. E. Gregory, Ch. of Bureau, will receive bids until Oct. 31 for one electric passenger elevator at the United States Veterans' Hospital, here.

Miss., Moorhead—The city will receive bids until Nov. 6 for the construction of waterworks plant, including pumping equipment, tower, tank, reservoir, etc. Estimated cost $40,000. H. A. Mentz, Magnolia, Consult. Engr.

Mo., Norborne—The city voted $129,740 bonds, $57,179 for waterworks system; $33,428 for lighting plant, etc.; $39,133 for sewers. R. R. McBride, Kansas City, Engr. Noted Sept. 25.

N. Y., Akron—The village holds an election Oct. 24 to vote on the purchase of a pump for waterworks. Estimated cost $6,000. Engineer not selected.

N. Y., Albany—C. J. Holding, Hotel Wellington, plans to build a 12 story, 60 x 80 ft. addition to hotel on State St. Estimated cost $275,000. Engineer or architect not selected.

N. Y., Binghamton—The Cutler Ice Co., Front St., is having plans prepared and will receive bids about Oct. 25 for the construction of first unit of artificial ice plant, about 30 ton capacity, at 310-340 Front St. Cost between $60,000 and $75,000. J. H. Neff, Binghamton, Engr. and Archt. Noted Sept. 11.

N. Y., Buffalo—J. A. Wetmore, Acting Supervising Archt., Treasury Dept., Wash., D. C., will receive bids until Nov. 7 for the installation of one full magnet electric passenger elevator, hoistway enclosure, etc., for the United States Custom House and Post Office, here.

N. Y., Green Island (Troy P. O.)—The J. A. Manning Paper Co., 68 George St., plans to build a 1 story, 38 x 150 ft. beater house. Estimated cost $350,000. The owner is in the market for six beaters, two Jordan engines and motors for 150 hp. plant.

N. Y., Jamestown—The Bd. of Public Utilities, M. O. Swanson, Supt., will receive bids until Nov. 1 for furnishing and installing a turbo-generator, condenser and auxiliaries; furnishing and erecting power house piping and traveling water screens at the Steele St. Lighting Plant. L. T. Klauder, Pennsylvania Bldg., Phila., Consult. Engr.

N. Y., Shushan—The state has had surveys completed for the construction of a dam to create a lake, 7 mi. long on the Battenkill River for regulating the water of the Hudson and furnishing hydro-electric power development. H. L. Cooper, 101 Park Ave., New York, Engr. I. C. Blandy, President of the Amer. Woodboard Co., Schuylerville, is interested in the project. Noted July 24.

N. Y., Vischer Ferry—Bureau of Canals & Waterways, E. S. Walsh, Comr., Capitol, Albany, will receive bids until Nov. 8 for the construction of superstructure of power house, etc., here.

N. C., Rocky Mount—The Bd. of Aldermen plans extension of water and light plant.

Ohio, Cleveland—The Euclid-East 84th Co., c/o J. J. Klein, Engineers Bldg., plans to build a 4 or 6 story apartment house, including steam heating system on East 84th St. and Euclid Ave. Estimated cost $600,000. Engineer or architect not selected.

Ohio, Cornersburg (Canfield P. O.)—Mahoning County, Youngstown, is having plans prepared for the construction of a 2 story hospital, separate heating plant with hot water heating system, direct method ventilation and high pressure boilers, on Craver farm, near here. Estimated cost $200,000. Stanley & Scheible, 1301 Wick Bldg., Youngstown, Archts. The owner is in the market for elevator, laundry, refrigerating and cold storage machinery, etc.

O., Massillon—The Central Steel Co. plans to build blast furnaces and auxiliary plants. Estimated cost $10,000,000.

Ohio, Massillon—The Massillon Water Supply Co. plans to drill several wells, install a 2,000,000 gal. electric pump and construct transmission lines, to increase daily capacity about 3,000,000 gal. Estimated cost $50,000.

Okla., Okemah—The city is having preliminary plans prepared for the construction of a reservoir, filtration plant and pumping equipment. Estimated cost $40,000. Holway Eng. Co., Wright Bldg., Tulsa, Engrs.

Pa., Bethlehem—The city, T. Ganey, Clk., will receive bids until Oct. 29 for the construction of a concrete reservoir, pumping station, installation of pumps, electrical work and pipe lines for high-level water system. R. L. Fox, Engr.

Pa., Tamaqua—The Higgins Hale Corp. will receive bids until Oct. 24 for the construction of a 4 story, 54 x 150 ft. hotel and theater on Broad and Pine Sts. Estimated cost $300,000. W. H. Lee, 1505 Race St., Phila., Archt. Equipment detail not reported.

S. C., Spartanburg—Lockwood, Green & Co., Engrs. and Archts., 24 Federal St., Boston, are preparing plans for the construction of the 10 story Montgomery theater and office building, here. Equipment detail not reported.

S. D., Watertown—The city, A. M. Myhre, Secy. Municipal Utilities Comn., will receive bids until Oct. 25 for waterworks improvements, including filter equipment and pump; piping equipment for filter house and pump station. W. F. Cochrane, Engr. Noted Oct. 2.

Tenn., Nashville — The Turner, Day & Woolworth Handle Co., 1404 Adams St., plans to build a handle factory to replace the one which was destroyed by fire. Estimated cost $100,000. The owner will equip plant and electrify all possible machinery.

Tex., Dallas—W. Davis et al., 1311½ Main St., are having plans prepared for the construction of an 18 or 20 story, 97 x 100 ft. bank and office building at 1305 Main St. Estimated cost $1,000,000. C. D. Hill & Co., Central Bank Bldg., Archts. Equipment detal not reported.

Tex., Dallas—W. C. Everett and associates, 416 East 12th St., have had plans prepared and will soon receive bids for the construction of a Fine Arts museum and auditorium on Commerce St. Estimated cost $750,000. R. H. Hunt & Co., S. W. Life Bldg., Dallas, Archts. Equipment detail not reported. Noted July 10.

Tex., Fort Worth — The Moslah Temple Shrine, c/o H. T. Pangburn, 4th and Houston Sts., plans to build a club building on Lake and Henderson Sts. Estimated cost $1,000,000. Engineer or architect not selected.

Tex., Ysleta—C. C. Cricket, P. O. Box 1014, is in the market for a 15 ton ice plant equipment, etc.

W. Va., Keyser—The city is having plans prepared for the construction of a 500,000 gal. steel storage tank and the installation of a motor driven centrifugal pump. Estimated cost $50,000. J. N. Chester Co., Union Bank Bldg. Pittsburgh, Engrs.

Wis., Ashland—The Ashland Daily Press, 321 West 3rd St., is receiving bids for the construction of a 2 story, 64 x 100 ft. printing plant. Estimated cost $50,000. Private plans. The owner is in the market for electric power machinery.

Wis., Berlin—The Schaefer Mfg. Co., F. Chapman, Pres., is receiving bids for steam heating plant, boilers, piping, radiation, etc. Private plans.

Wis., Clintonville — The city, J. Spearbraker, Clk., plans an election to vote $150,000 bonds for the purchase of Big Falls water power and the construction of a power plant and transmission line from Big Falls, here. Engineer not selected.

Wis., Hurley — The city, J. Emunson, Clk., will soon award the contract for the construction of water purification plant and pumping station, including intake pipe. Cost between $35,000 and $40,000. J. H. A. Brahtz, 409 Metropolitan Opera House Bldg., St. Paul, Minn., Engr.

Wis., Milwaukee — Cahill & Douglas, Engrs., 217 West Water St., are receiving bids for furnishing about twenty electric motors from 2 hp. to 40 hp., and one panel switchboard for the Hilty Lumber Co., foot of 12th St.

Wis., Milwaukee—J. Hunholz, 2310 Vliet St., is having plans prepared for the construction of two 8 story, 50 x 108 ft. apartment houses on Marshall and Mason Sts. Estimated cost $425,000 each. Private plans. Equipment detail not reported.

Wis., Sheboygan—The city, C. N. Boley, Pres., will purchase equipment and build a central heating plant at the City Farm by day labor. R. R. John, City Hall, Engr. Noted Sept. 25.

Australia, Melbourne — The State Electricity Comn. of Victoria, R. Liddelow, Secy., will receive bids until Jan. 19, 1924, for transformers, switchgear and accessories, substation B for Morewell Power Scheme.

T. H., Pearl Harbor — The Bureau of Yards & Docks, Navy Dept., Wash., D. C., plans the installation of generators, transformers, mess switchboard and substation equipment, here.

CONTRACTS AWARDED

Calif., Los Angeles—The Crescent Creamery Co., 237 Winston Ave., awarded the contract for the construction of a creamery, including a 2 story milk plant, ice cream manufacturing plant and a 1 story boiler house, on Slauson Ave., to R. E. Milsap, Marsh Strong Bldg., Los Angeles. Estimated cost $112,000. Noted Oct. 2.

Calif., Los Angeles—J. Toplitzky, H. W. Hellman Bldg., awarded the contract for the construction of a 12 story bank and office building on Spring and 7th Sts. to the Scofield Eng. & Constr. Co., Pacific Finance Bldg., Los Angeles. Estimated cost $1,250,000. Equipment detail not reported. Noted July 24.

Calif., San Pedro—L. De Carlo, c/o L. L. Jones, Archt., Grosse Bldg., Los Angeles, awarded the contract for the construction of a 6 story hotel on 7th St., here, to Hayes & Son, 143 East 3rd St., Long Beach. Estimated cost $215,000. Equipment detail not reported. Noted Oct. 2.

Colo., Denver—The Norman Apartments, Inc., 915 Central Savings Bank Bldg., awarded the contract for the construction of a 6 story, 150 x 150 ft. apartment house, including two elevators, on Downing Blvd. to G. M. Tamblin, Sweeney Bldg., Denver. Estimated cost $500,000. Noted Sept. 25.

D. C., Bellevue—The Bureau of Yards & Docks, Navy Dept., Wash., awarded the contract for the construction of a barracks, garage and generator buildings at the Naval Experiment and Research Laboratory, here, to A. H. Rogers, 616 Colorado Bldg., Wash., $23,400. Noted Aug. 14.

Ill., Chicago—S. Dlott, 179 West Washington St., awarded the contract for the construction of a 146 x 275 ft. hotel on Broadway and Buena Terrace to Paschen Bros., 111 West Washington St. Estimated cost $2,250,000. Steam heating system will be installed.

Kan., Wichita—The B. P. O. E., c/o H. G. Boyd, 10 Elks Lodge, awarded the contract for the construction of a 5 story, 140 x 150 ft. club building on 1st and Market Sts. to the G. H. Siedhoff Constr. Co., Broadview Hotel Bldg., Wichita, $315,624; heating and ventilating apparatus to the Moore-Robertson Heating Co., Wichita. Total estimated cost $500,000. The owner will purchase elevators. Noted Sept. 18.

Ky., Louisville—St. Joseph's Infirmary, [illegible] St., awarded the general contract for the construction of a 7 story hospital on [illegible]tern Parkway and Preston St. to the [illegible]ich Constr. Co., 147 North Clay St., [illegible]isville. Estimated cost $1,500,000. Equipment detail not reported. Noted Sept. 25.

Mass., Lynn—The Lynn Gas & Electric Co. awarded the contract for the reconstruction of the electrical bay of power station, including masonry bus compartments, switch cells, batteries and the installation of electrically operated switch gear, etc., to S[illegible] & Webster, Inc., 147 Milk St., Boston.

Mo., St[illegible]—The Medart Mfg. Co., Dekalb and [illegible]ac Sts., awarded the contract for a [illegible]40 ft. boiler room to the Woermann C[illegible]tr. Co., Syndicate Trust Bldg., St. L[illegible] Estimated cost $10,000.

N. Y., New [illegible]—The Amer. News Co., 11 Park Pl., awarded the contract for the construction of [illegible] story, 150 x 175 ft. office building [illegible] Varick St. between Dominick and Spring Sts. to the Turner Constr. Co., 244 Madison Ave., New York.

N. Y., New York — The Nine Hundred Thirty Three Park Ave. Corp., c/o Sugarman, Hess & Berger, Engrs. and Archts., 18 East 43rd St., will build an apartment house on Park Ave. by day labor. Estimated cost $600,000. Equipment detail not reported.

N. Y., New York — Phipi, Surge, Lhue, Inc., 18 East 41st St., awarded the contract for the construction of a hospital on 72nd St. and West End Ave. to the Natl. Constructors & Engrs., 18 East 41st St. Estimated cost $1,000,000. Equipment detail not reported.

W. Va., Kanawha (Charleston P. O.)—The Libby-Owens Sheet Glass Co. awarded the contract for the construction of a pump house and intake bulkhead in the Kanawha River to the Devoe Co., Toledo, Ohio. Cost will exceed $25,000.

Wis., Kenosha—The Kenosha Fruit Co., 452 Pearl St., awarded the contract for the construction of a 1 story, 60 x 132 ft. warehouse to Bondgard & Christensen, 1135 Mound Ave., Racine. Estimated cost $50,000. The owner is in the market for refrigeration machinery.

B. C., Victoria—The Dominion Government, Ottawa, Ont., awarded the contract for the construction of buildings; machinery; three 60,000 gal. pumps with 1,000 hp., 2,200 volt; two auxiliary pumps, 9,000 g.p.m.; fire hydrants; complete lighting system; nine electric capstans at Esquinalt dock here, to Hodson, King & Marble, 626 Pender St., W., Vancouver. Estimated cost $350,000.

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